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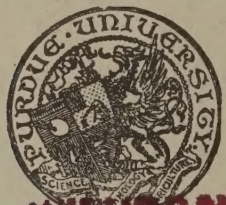

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INTERNATIONAL RAILWAY CONGRESS ASSOCIATION

EIGHTH SESSION

BERNE : JULY, 1910

PROCEEDINGS

VOLUME III

INTERNATIONAL

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ASSOCIATION

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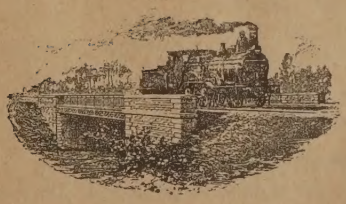

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3RD SECTION — WORKING

OPENING MEETING

4 July 1910, 4.50 p. m.

PROVISIONAL PRESIDENT, MR. FAIRFAX HARRISON,
MEMBER OF THE PERMANENT COMMISSION OF THE CONGRESS.

The President. (In French.) — Gentlemen, the Permanent Commission has charged me with the installation of the 3rd section. It has requested me to propose to you that the following shall be the officers forming the bureau of this section :

1° As president : Mr. DIETLER, engineer, formerly president of the board of the St. Gothard Railway, member of the Permanent Commission of the Congress. (*Applause.*)

2° As vice-presidents : Mr. TONDELIER, traffic director of the Belgian State Railway, member of the Permanent Commission of the Congress; Dr. R. ULBRICHT, member of the Board of Works, councillor of the royal ministry of finance of Saxony, member of the Permanent Commission of the Congress; and Mr. WEISS, chief engineer of bridges and roads, manager of the French Eastern Railway, member of the Permanent Commission of the Congress. (*Applause.*)

3° As principal secretaries : Mr. AHONEN, general manager of the Finland State Railway; Mr. KAREISCHA, State councillor, professor, engineer of ways of communication, vice-manager of the traffic department of the ministry of ways of communication of Russia; and Mr. VERLANT, assistant chief engineer of the Paris-Lyons-Mediterranean Railway. (*Applause.*)

(Mr. Fairfax Harrison vacated the chair which was then occupied by Mr. Dietler.)

Mr. Dietler. (In French.) — Gentlemen and dear colleagues, as it is now not the time for official speeches, I limit myself to thanking you for the confidence you have just shown in me and for the honour you have bestowed on my country in appointing me president of the 3rd section.

As you know, there is quite enough

63385

before the Congress, and the technical world expects from us solutions which are such as to help the development of the railway industry. Hence, we must work. As far as I am concerned, I shall do all that is possible to render our labours fruitful and I am convinced that you on your side will do the same. (*Approval.*)

— On the proposal of the president, the SECTION then appointed the other members of the bureau and drew up provisional agenda.

SECTION III : WORKING

[656 .211 & 656 .212] QUESTION IX

LARGE STATIONS

A. Large passenger stations. — *Best arrangement of tracks so as to increase their working capacity and ensure safety in shunting operations. Improved mechanical appliances for the conveyance of luggage, etc.*

B. Large goods stations. — 1° *Arrangements of tracks :* a) *to allow the continuity of movement of vehicles which require shunting and which are separate from the time the train bringing them has arrived until the train taking them away is being made up;* b) *to prevent such movement from being interfered with by the arrival or departure of trains;* c) *to stop without shock such separate vehicles at the end of the successive movements required;* d) *to start them off again.*

2° *New appliances for handling goods.*

Reporters :

America. — Mr. H. A. Jaggard, superintendent, Pennsylvania Railroad.

Russia, Austria, Hungary, Rumania, Bulgaria, Servia and Turkey. — Mr. A. Kain, engineer, inspector of the Hungarian State Railway.

Other countries. — Mr. Jullien, chief way and works engineer of the Orleans Railway, and Mr. Leverve, assistant traffic manager of the Orleans Railway.

QUESTION IX

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[656 .211 & 656 .212]

REPORT N° 1

(All countries except America, Russia, Austria-Hungary, Rumania, Bulgaria, Servia and Turkey)

By Mr. JULLIEN,

CHIEF WAY AND WORKS ENGINEER OF THE ORLEANS RAILWAY,

and Mr. LEVERVE,

ASSISTANT TRAFFIC MANAGER OF THE ORLEANS RAILWAY.

In the present report, we shall reproduce in succession the different questions contained in the list of questions which we sent out to the administrations concerned; at the end of each we shall give a summary of the answers we have received, and the general impression to be drawn from them. We shall then at the end give the conclusions to which we consider they lead.

LITTERA *A*.

Large passenger stations.

1° *Have you adopted any special arrangements in order to increase the working capacity of your stations and to ensure the safety of the shunting operations? More especially :*

a) Are the tracks for main line trains grouped together in a set separate from the set of tracks used for suburban trains?

The arrangements generally adopted in order to increase the working capacity of

large passenger stations consist in the separation and specialization of the installations used for the different station services.

In the first place, everything in connexion with the operation of goods trains is kept separate; special tracks not affecting the passenger tracks are used for the purpose, and even the local services and the shunting operations are dealt with at one or several separate stations.

Special premises are used for the parcels, perishables, vegetables and cattle traffic, and also for the mails; and when there is enough, such traffic trains are run for parcels or for mails only. (There is one fast train, between Paris and Marseilles, carrying mails only.)

Finally, the different lines run in to the station each on a separate track, and these tracks are grouped according to the importance of their traffic, care being taken to avoid crossings, at the same level, in the case of the regular service.

The safety of the arrival and departure movements is ensured by mechanical or electrical interlocking gear. The number of switches on main lines is limited to as few as the exigencies of the service allow. When the subordinate lines have to be connected with the main lines, they are equipped with scotch blocks or, as seems preferable, with refuge sidings.

At the large stations where there is both a large suburban traffic and a large main-line traffic, it is advisable to keep separate the installations for the suburban traffic and the main-line traffic, as the services have different requirements. On lines with very much traffic, the tendency has been to double the tracks by placing alongside the main lines double tracks to accommodate the suburban traffic.

The distinction between suburban tracks and main-line tracks however only exists, in an absolute manner, at some large stations where the suburban traffic is of exceptional importance. We may mention more especially the stations of the Western-State system at Paris : Montparnasse, Les Invalides and St. Lazare.

The Paris St. Lazare station is at present in a state of alteration. The work at present carried out there is intended to increase the capacity of the station and of the lines which go there. The present number of tracks is twenty-seven, sixteen of which are used for the suburban service. This will be increased to thirty-three, including eighteen suburban tracks; six of these will be electrified and placed on a lower floor. The station will thus have tracks on two floors, the system adopted being thus analogous to that which is being carried out at New York, in the case of the terminal station of the New York Central and Hudson River Railroad.

At a large number of stations where the suburban installation and the main-line installation are not kept strictly separate, some tracks are however exclusively reserved for the suburban service.

At the Paris Nord station, there are fifteen tracks used for the suburban service only, and either tramway trains or ordinary trains are run on them. But a certain number of other tracks are used either for main-line, of for suburban trains; it

was possible to group the trains of these two services at certain hours of the day. Such an organization makes a more complete utilization of the station tracks possible.

It sometimes happens at roadside stations that secondary lines are run from dead-ended platforms placed at the ends of the passenger-station building (for instance, North Eastern Railway station at York, Strasburg station, Hirschberg station in Silesia). We may also instance the arrangement of the stations at Berlin, where the metropolitan Stadtbahn lines are together with the main lines; the same is the case at the Hamburg stations, with the electrically-operated lines of the Stadtbahn.

In addition to the separation and the specialization of the installations, the working capacity of the stations is also increased by reducing to a minimum the shunting operations required, such as changing the composition of the trains, and by making these independent of the arrival and departure movements of the trains.

Such measures are more especially necessary in the case of suburban services on account of the density of the traffic.

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b) Are the suburban tracks arranged so as to reduce shunting operations to a minimum? Have you for instance adopted, as the solution, end loops at certain stations, as at Boston station (U. S. A.)?

The way in which the tracks are arranged so as to make it possible for the locomotives to pass from the head to the tail of trains, such as running lines connected by switches to passenger tracks at both ends, is the same in the case of the main lines as in that of suburban lines.

As a rule, any alteration in the composition of suburban trains is avoided, particularly if the traffic is dense and regular. The only provision then made at the terminus stations consists in arranging the tracks in such a way that locomotives can easily be changed or taken quickly from one end of the train to the other.

At the Paris Bastille station, an electric traverser connects the dead-ends of the tracks at the station, and is used to shift the locomotives from one track to another.

At the Paris Quai d'Orsay terminus station, where the lines are electrified, an electric traverser makes it possible to shift the motor cars from one track to another. But it is, as a principle, not utilized for the suburban service. The electric service on the line from Quai d'Orsay to Juvisy is as a matter of fact effected by sets of carriages always arranged in the same way; they are propelled by two motor cars, placed at the head and at the tail, which are controlled simultaneously by a driver who is at the head of the train. All the driver has to do at the terminus is to move from one end of the train to the other. This is a very valuable advantage of electric traction.

*

Fig. 1. — **Shunting y**

The object of the depot at Grunewald is to receive during the night part of the trains, and locomotives, which run on the metropol extension of the metropolitan (immediately to the west of the Grunewald passenger station), with wich it is joined by a special double-tra

In order to avoid any level crossings of the main lines, the depot is placed between the three main lines. It is to include fived se four only, the sets A, B, C, D, are actually built; they can accommodate 40 trains.

Nearly all the tracks of these five groups are connected by switches at both ends. The tracks of group A have an available lengt washing the trains, and also, at hours of little traffic, for storing the trains.

It is a principle, that the composition of trains is not modified; thus sorting sidings are unnecessary. When damaged carriages ha the sidings well connected with the arrival and departure tracks as well as with the locomotive sheds, for the trains must be able to enter

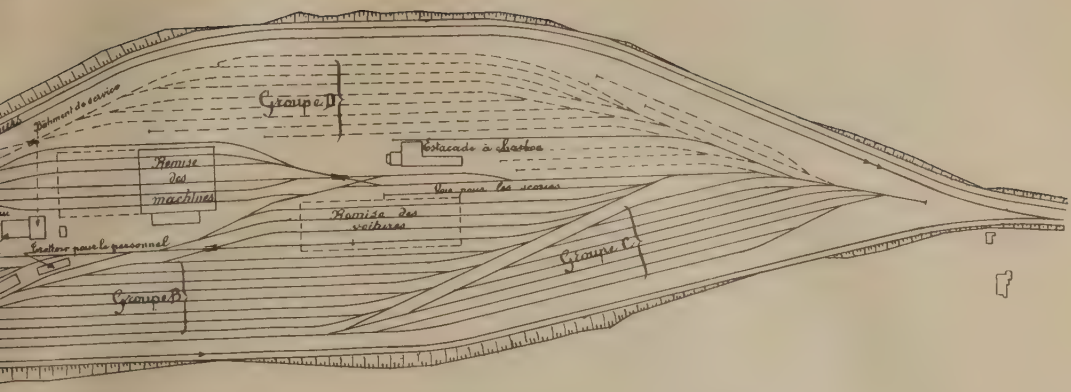
All the accessory installations had also to be provided, such as locomotive sheds, staff offices, washing appliances, etc.

Explanation of French terms : Trottoir = Platform. — Groupe = Set. — Gare de marchandises = Goods station. — Délivrance des billet — Voies pour les scories = Track for ashes. — Estacade à charbon = Coal tips. — Château d'eau = Water-crane. — Voie de voyage = Heating apparatus. — Magasin = Store. — Bâtiment de service = Office building. — Trottoir pour le personnel = Platform for en

At the terminus stations of the lines operated with tank locomotives with a small wheelbase, there are also used turn-tables placed at the ends of the main lines and the running lines which are arranged in such a way that the turn-table in question can be used for two or three of them.

These turn-tables make it possible, by one single operation, to direct the locomotive so that it can pass from one track to another.

The solution of the end loop, which was first recommended by the French Northern Railway and which has been applied so largely on the Paris metropolitan system, does not appear to be used in Europe for main-line stations. The only instance we know of elsewhere is at Boston-South, U. S. A., and we believe that even that is at present not being used.



newald near Berlin.

lines, as well as on the eastern suburban lines. During this time the trains are examined and cleaned. This depot is on the western at the movements of the train are quite independent of the passenger trains running on the main line.
ch will accommodate 52 metropolitan or suburban trains about 180 metres (590 feet) long, as well as the spares necessary. Of these five sets,

219 yards) and can take one train; nearly all the tracks of the other groups can take two trains. Group A is utilised during the day for

or when other similar operations of minor importance are carried out, the depot tracks are used. It has been necessary to have short period of time. When the service starts, all the trains have to leave the depot within an hour and a half or two hours.

very. — Voies de grands parcours = Main lines. — Remise des machines = Locomotive shed. — Remise des voitures = Car shed. arcours = Passenger main-line. — Voie de jonction avec la gare de remisage = Junction with station depot. — Chaufferetterie ment de halte = Remises for stopping.

c) How are tracks arranged so as to make it possible :

I) *to change locomotives quickly ;*
II) *to add or take off carriages ;*
III) *to make up trains, or to bring to the platform trains made up on a special set of sidings ?*

I. — The tracks to enable locomotives to be changed quickly are, as a rule, tracks placed at the side of the main line on which this change is to be effected.

These tracks are connected at both ends by means of switches, or else are dead-ended and then connected in the departure direction of the trains which have to have their locomotives changed. Mereover, the locomotive sheds are connected with the tracks at the station by one or two independent lines.

At large stations, particularly if the locomotive sheds are at some distance from the centre of the station, it is very useful to have near the platforms and between the main lines, sidings for the locomotives and even to equip these sidings with a turn-

table, a water-crane and a coal store, so as to form a sort of auxiliary locomotive depot, readily accessible.

This arrangement appears advisable at large stations when the connections do not make it possible to run from the chief locomotive sheds to the different platform tracks without blocking a number of lines.

II and III. — The arrangement of tracks to make it possible to add or take off carriages is the same as that adopted in the case of locomotives and described above.

But it is also necessary to have sets of sidings available sufficiently large, for making up and washing the trains, connected with the platform tracks by lines as independent of the main lines as possible.

At the Dresden Altstadt station, a special set of sidings is provided for making up trains; the ready trains are then taken from there to the platforms of the station, which are at a distance of 1·5 kilometres (0·93 mile).

When the number of trains which have to be stabled is very large, actual depots are built for the purpose, such as the Grunewald depot near Berlin (see plan fig. 1) for stabling the metropolitan and suburban trains, where there is accommodation for 52 trains each 180 metres (590 feet) long. We reproduce in the appendix a note on the subject of this station, which was sent to us by the Berlin Direction of the Prussian-Hessian State Railway, together with a plan of the depot.

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d) Have you any stations with separate floors, in which the tracks are, either all or in part, either on an upper floor or in a basement, the ground floor being used for different offices (enquiry offices, booking offices, luggage offices)?

In the case of a mixed arrangement, that is to say, when some of the tracks only are at another level than the ground floor, which tracks are at that level and which tracks are on the ground floor?

In the case of stations with separate floors, how are the different services distributed between the ground floor and the other floor?

What circumstances : topographic location, difficulty of widening, etc., have led to the adoption of separate floors?

What advantages do you consider this arrangement to have to make up for the increased amount which as a rule such a station costs to build and run?

The solution of a station with several floors, presents several very serious advantages : in the first place, at a station where there is much traffic, and where consequently the passengers must not be allowed to walk across the lines, they save the passenger a useless ascent or a useless descent.

It makes it easy to carry out the luggage service without inconveniencing the passengers. It does not in any way interfere with the urban traffic, as the streets of the town pass below or above the iron roads. It thus contributes to the safety of the traffic both on the railway and on the streets of the town.

Finally, it reduces as a rule the area of land required, and consequently the expenditure is less.

From the latter points of view, this solution may become the only possible one when building a new station or enlarging an old one which is in the middle of a large town. Such is the case at the Quai d'Orsay, Invalides and St. Lazare stations at Paris.

The solution of a station with several floors is very usual in Germany, and it may be said that it is always adopted when circumstances make this possible.

This solution has also been adopted, but less frequently, in France, particularly at the Quai d'Orsay and the Invalides stations. It is proposed, as we have already stated, to apply it at the St. Lazare station : the suburban lines will then be placed under the main lines, that is to say, at the same level as the neighbouring street.

The St. Lazare station will then be of the mixed type, like the Dresden Altstadt station, where the lines are also at different levels : those which run through the station are at the higher level and those for which it forms the terminus are at the lower level.

In the case of stations with floors, the floor which is on the same level as the public streets is as a rule used for the booking offices and for luggage offices, both for the receipt and the distribution of luggage. The other service offices and the refreshment rooms are on the other hand on the same level as the platforms.

The waiting rooms are sometimes on the ground floor, sometimes at the same level as the platforms.

---

e) Have you adopted the solution of « double platforms » applied more especially on the French Northern Railway at St. Omer and Valenciennes stations (Revue générale des chemins de fer. November 1904 and May 1907) ?

This solution does not seem to have been adopted, apart from the French Northern Railway (Valenciennes and St. Omer stations), except at the Mans station (Western-State). Below we give diagrams showing the arrangements at these three different stations (figs. 2 to 4).

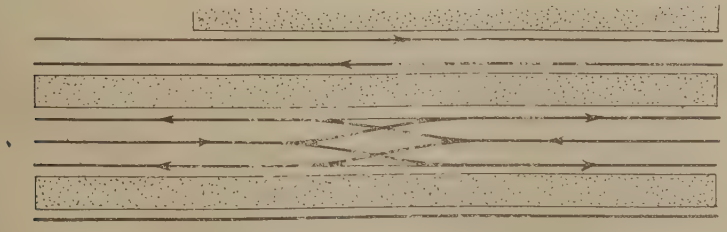

Fig. 2. — St. Omer station.

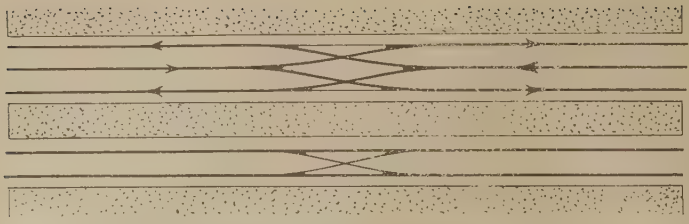

Fig. 3. — Valenciennes station.

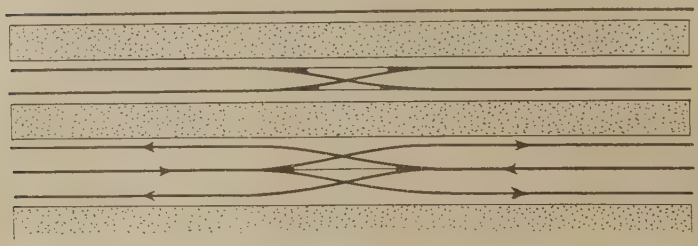

Fig. 4. — Mans station.

The administration of the Alsace-Lorraine State Railway propose to adopt a similar arrangement, as show in the diagram below (fig. 5).

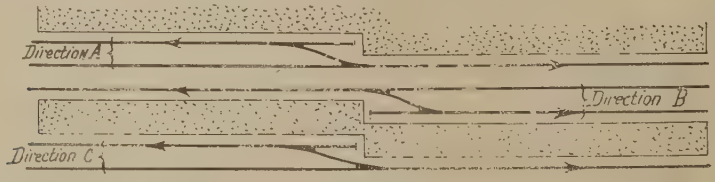

Fig. 5.

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f) Please enclose in your answer plans of the passenger station or stations on your railway, of each of the types considered (station at one level, mixed station, station with separate floors), which seem to you to satisfy most completely the two desiderata mentioned above : namely to increase the working capacity and the safety of the shunting operations. It would be of interest to state how many reception tracks for passenger trains there are at the stations in question, and how many trains are received on the whole of these tracks during twenty-four hours.

We are unable to reproduce the numerous plans we have received, and in which the arrangements described above are more or less carried out. We will only give

some of the figures supplied to us, showing the maximum number of trains per day at some of the stations, as well as the number of tracks available at those stations.

GERMANY.

Hamburg, 10 tracks : 217 main-line trains; 264 metropolitan trains.
Breslau, 9 tracks : 225 trains.
Frankfort, 18 tracks : 625 trains.
Dresden-Altstadt, 13 tracks : 227 trains.
Strasburg, 7 tracks : 274 trains.

GREAT BRITAIN.

London (Liverpool street), 18 tracks : 600 trains; 95,000 passengers.
Nottingham (Victoria), 14 tracks : 420 trains.
Glasgow (Caledonian), 13 tracks : 300 trains.

FRANCE.

Paris-St. Lazare, 27 tracks : 600 trains; 83,000 passengers.
Paris-Nord, 28 tracks : 500 trains.

SWITZERLAND.

Bale, 10 tracks : 219 trains.
Zurich, 11 tracks : 307 trains.

2° Please describe the mechanical appliances you have, either at the stations with separate floors, or at the stations at one level :

a) For the conveyance of luggage (lifts, motor tricycles, travelling endless belts, etc.).
b) For the conveyance of passengers (lifts, travelling inclines, moving staircases, etc.).
c) To your answer please add particulars add drawings of the appliances mentioned under a) and b).

---

a) Lifts for the luggage service are used very extensively in Germany. This naturally results from having stations with several floors. These lifts are either hydraulic or electric.

The electric lifts are generally actuated by an endless screw acted on by the electric motor; this screw takes into the screw thread of the piston. The endless screw runs in an oil bath.

At Hamburg, an endless belt driven electrically is used; the arrangement is shown in the following figures (fig. 6).

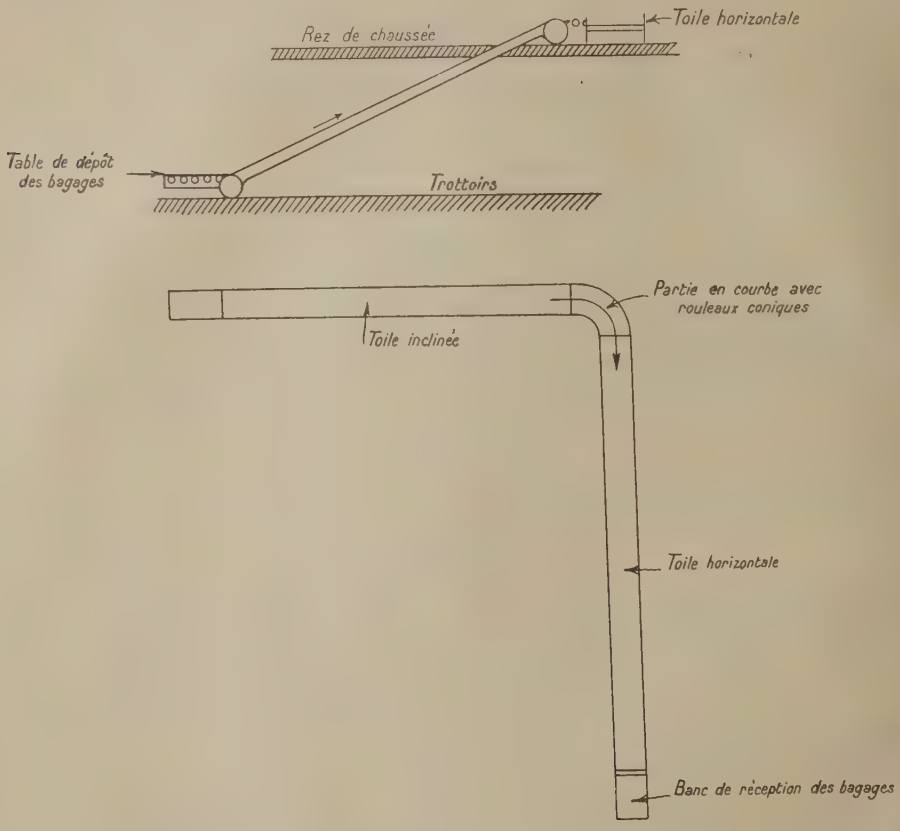


Fig 6.

Explanation of French terms : Rez-de-chaussée = Ground floor. — Toile horizontale = Horizontal belt. — Table de dépôt des bagages = Table for the luggage — Trottoirs = Platform. — Toile inclinée = Inclined belt. — Partie en courbe avec rouleaux coniques = Curved part wish coned rollers. — Banc de réception des bagages. — Table for receiving the luggage

At the Quai d'Orsay station, at Paris, there are also electric lifts; endless belts are extensively used for the conveyance of luggage.

A detailed description of this installation is given in the July 1901 number of the *Revue générale des chemins de fer;* it consists principally of an inclined belt to overcome the difference of height of 5·17 metres (17 feet) which exists between the tracks and the upper floor where the luggage is delivered; then of a canted portion where

the luggage is tilted on to benches the top of which is also movable. The luggage is thus brought along in front of the porters who take it as it passes. The plan and section (see fig. 7) show the arrangement of the installation.

The Paris Invalides station also has such belts for the conveyance of luggage.

The automotor tricycles tried in the United States by the Pennsylvania Railroad, have also been tried by the French Northern Railway.

b) Passenger lifts are but little used at the main-line stations; they seem chiefly used at city stations, as in London, where the difference of level is considerable; they are then constructed in such a way as to be able to accommodate a large number of passengers at once.

At Hamburg station, however, there are lifts for this purpose; also at some of the Paris stations, for instance at Montparnasse and Quai d'Orsay; they are however but little used by the public.

On the other hand, there is installed at Quay d'Orsay station a moving staircase which is much appreciated by the public. Such a staircase is also used at the Magasins du Bon Marché and at the Père-Lachaise station (Paris Metropolitan); and it has more than doubled the rate of movement of the passengers. A description of it is given in the June 1908 number of the *Revue générale des chemins de fer*. We give views and photographs of it in figures 7 to 11.

LITTERA *B*.

Large goods yards.

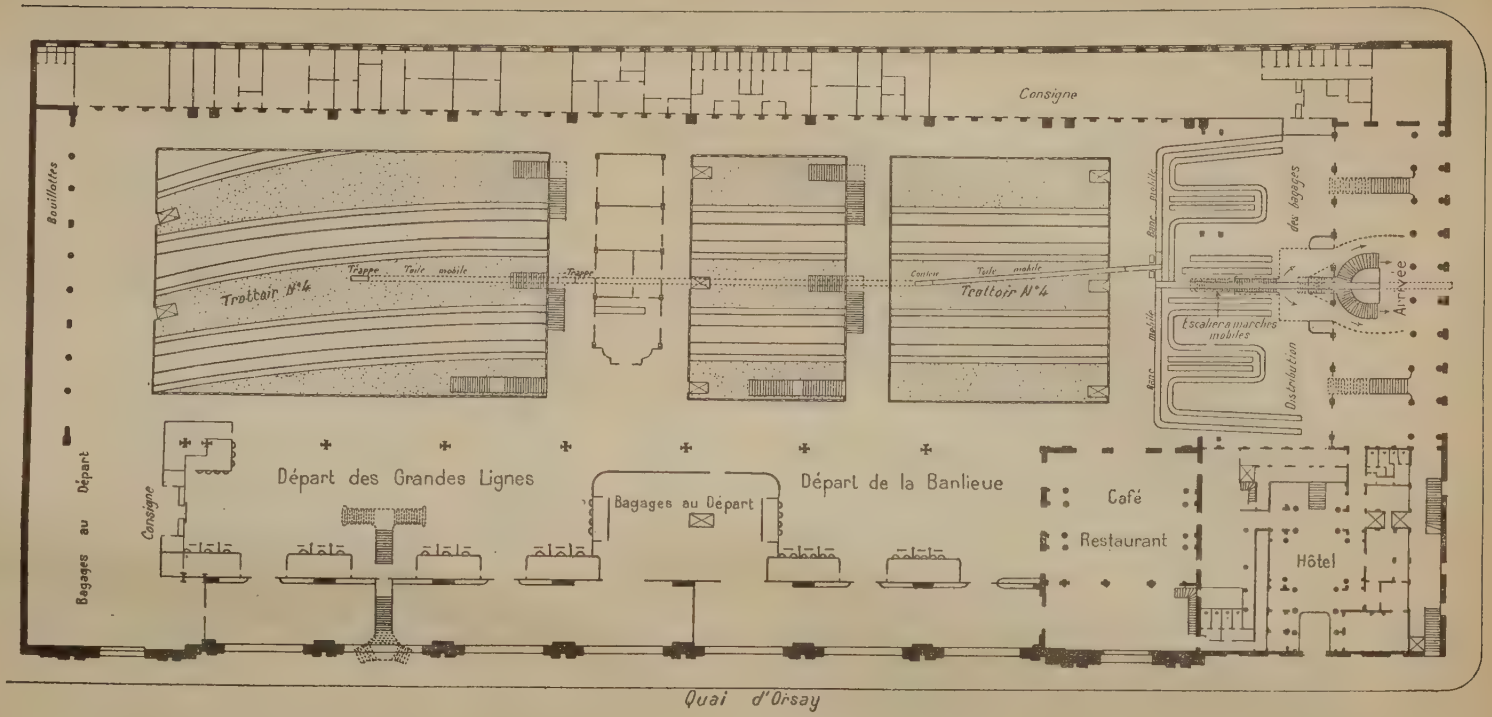
1° *Are the sidings at some of your sorting and shunting yards arranged so as to ensure the continuity of the movement, in one given direction and consequently without any reversal, of the cars to be dealt with, from the time an arriving train is received until a train is made up and ready to leave?*

Generally speaking, the large sorting and shunting yards of recent construction consist essentially of four sets of sidings over which the wagons which are being sorted pass from their entry to their egress:

The reception sidings on which the trains to be sorted are received when they arrive, and from which the wagons are sent on direct either by being shunted on to a saddle-back, or by the effect of a continuous incline on to the set of sorting sidings;

The set of sorting sidings which includes a number of sidings varying with the number and the importance of the lines terminating at the station and of the sorting which has to be effected;

Plan du rez-de-chaussée.



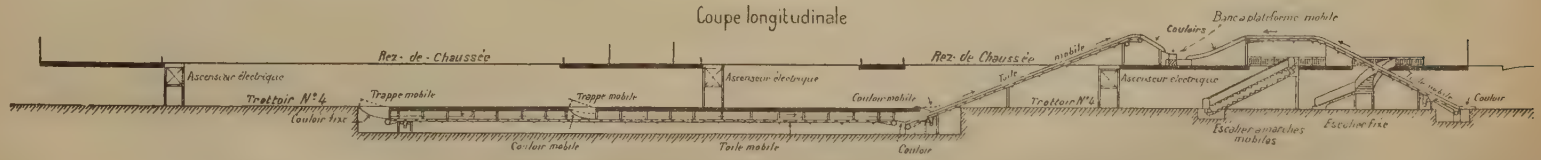


Fig. 7. — Installation of a staircase with moving steps at Quai d'Orsay station.

Explanation of French terms : Plan du rez-de-chaussée = Plan of ground floor. — Bagages au départ = Departure, luggage. — Consigne = Cloak room. — Départ des grandes lignes = Departures, main line. — Départ de la banlieue = Departures, suburbs. — Escaliers à marches mobiles = Staircase with moving steps. — Distribution des bagages = Distribution of luggage. — Arrivée = Arrival. — Toile mobile = Travelling belt. — Trappe = Trap. — Trottoir n° 4 = Platform No. 4. — Banc à plateforme mobile = Bench with movable top. — Bouillottes = Heating apparatus. — Escalier fixe = Fixed staircase. — Ascenseur électrique = Electric lift. — Rez-de-chaussée = Ground floor. — Coupe longitudinale. = Longitudinal section. — Trappe mobile = Movable trap. — Couloir = Passage. — Couloir fixe = Fixed passage. — Couloir mobile = Movable passage.

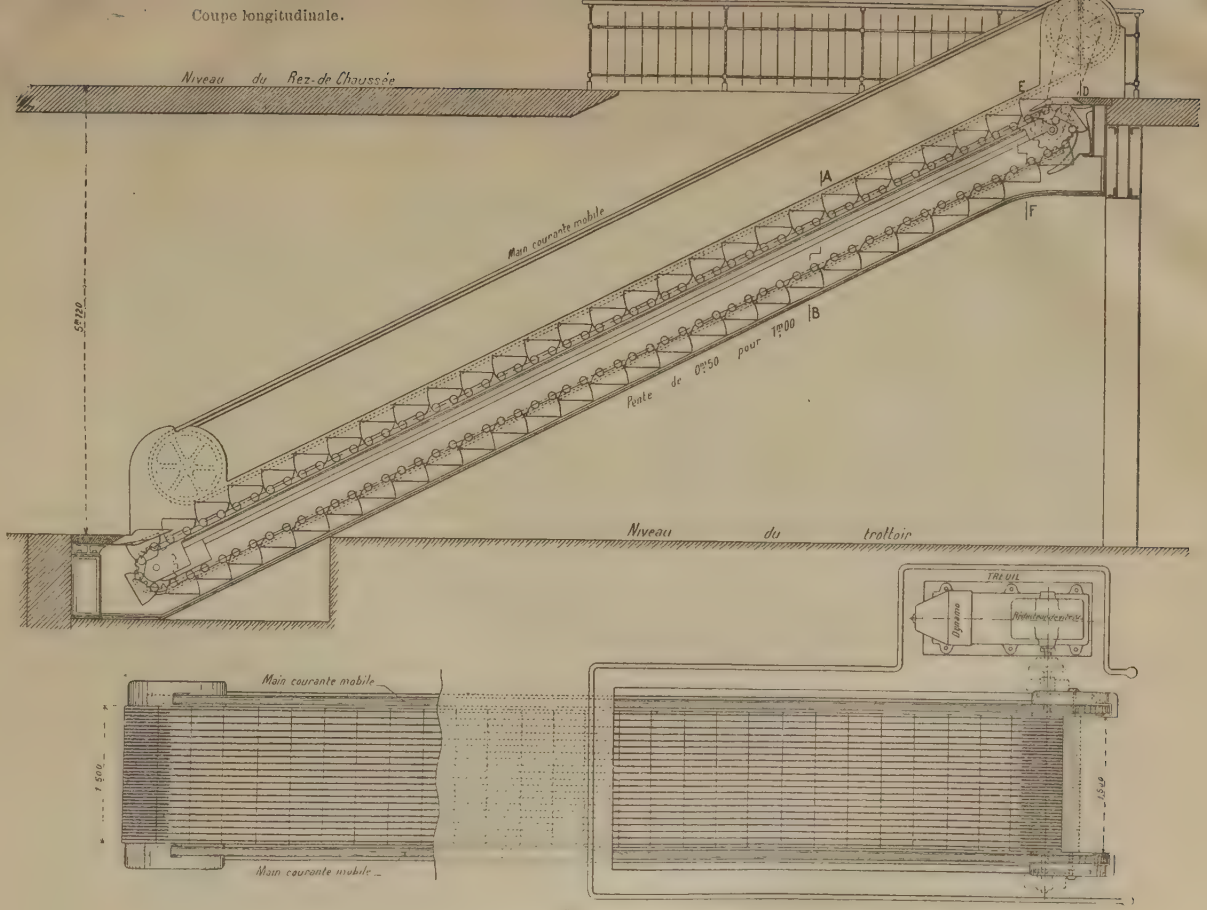


Fig. 8. — Installation of a staircase with moving steps at Quai d'Orsay station.

Explanation of French terms : Niveau du trottoir = Level of platform. — Niveau du rez-de-chaussée = Level of ground floor. — Coupe longitudinale = Longitudinal section. — Main courante mobile = Moving hand rail. — Treuil = Windlass. — Réducteur de vitesse = Speed reducer. — Pente de 0.50 mètre pour 1 mètre = Slope of 1 : 2.

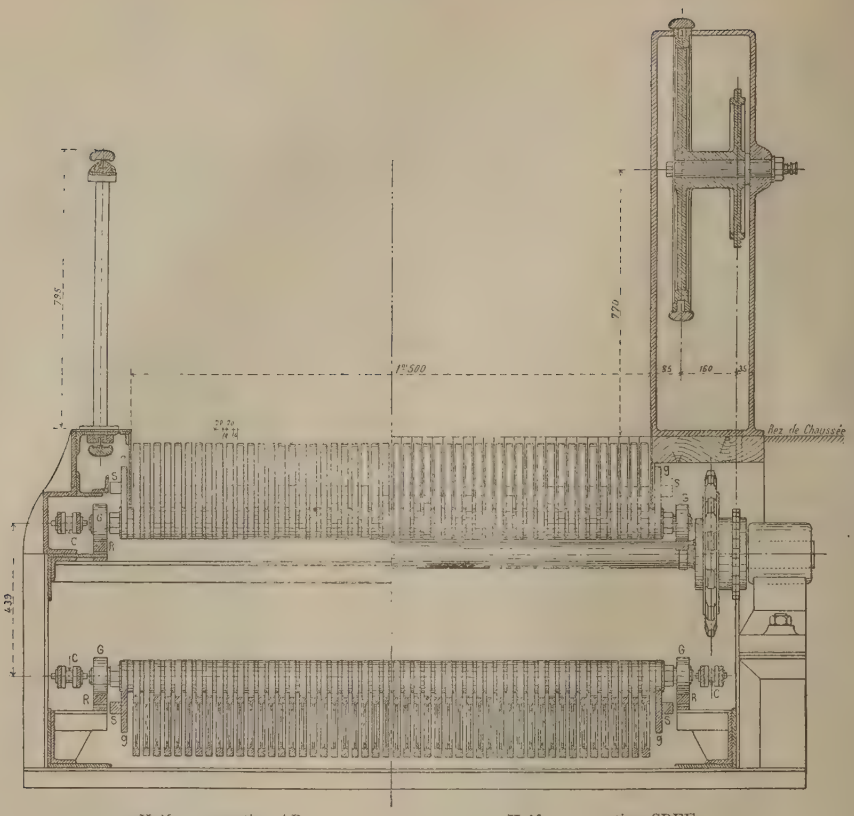


Fig. 9. — Installation of a staircase with moving steps at Quai d'Orsay station.

Explanation of French term : Rez-de-chaussée = Ground floor.

From these sorting sidings the wagons pass, either by continuous incline, or after being shunted on to a saddle-back, on to one or more smaller sets of sidings or gridirons, where the geographical classification is effected;

From these gridirons the wagons are taken either by the action of gravity or by means of a shunting locomotive, on to the departure sidings.

The system described under 1° of the list of questions has now been in existence for a long time at Terrenoire (near St. Etienne, Paris-Lyons-Mediterranean Railway) and at Edge Hill (near Liverpool, London and North Western Railway). It is being applied more or less completely at those places where local conditions admit of it. This has been done at Lumes (near Charleville, French Eastern Railway) and is at

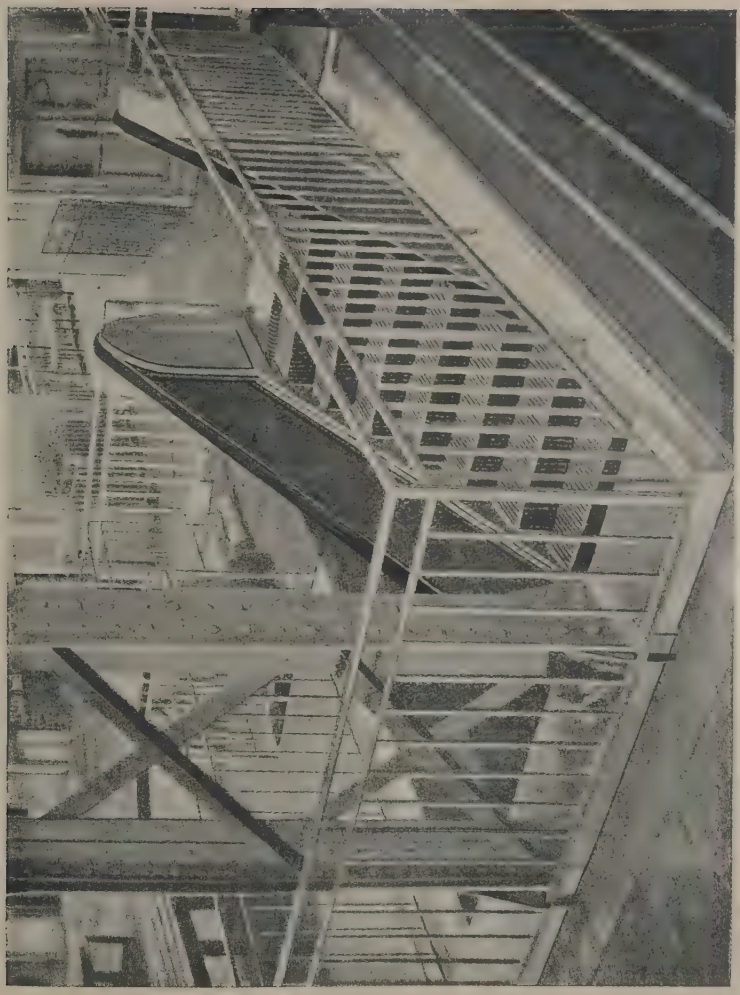


Fig. 10. — Installation of a staircase with moving steps at Quai d'Orsay station.

Fig. 11. — Installation of a staircaise with moving steps at Quai d'Orsay station.

present being done at those sorting yards which are being rearranged or constructed on the Orleans Railway (Les Aubrais, St. Pierre-des-Corps, Vierzon, Coutras, etc.).

The same is the case at the more recent large sorting yards in Germany : Mannheim, Nuremberg, Dresden, Osterfeld-Süd (near Essen), Hausbergen (near Strasburg), Engelsdorf (near Leipzig), Brockau (near Breslau), etc.

The same is the case at the large sorting yards in Great Britain : Dunford and Wath (Great Central), Shildon (North Eastern), Ross (Caledonian), Temple Mills (Great Eastern), etc.

The Belgian State Railway has as yet no yards of this kind, but is working at projects of this kind for the important yards Schaerbeek and Welkenraedt.

In Switzerland, the Zurich and Bâle sorting yards are partly of this kind.

---

a) Are these sidings on a continuous incline so that the cars can be sorted by gravity without requiring a locomotive, or do they consist of successive sets of sidings on the flat, commanded by saddle-backs on to which the trains are pushed by the locomotive? Are there successive gridirons which allow a train to be classified according to destination and on which the making up of a train can be completed ?

As a rule there are saddle-backs; the lines are then on the flat or on a gentle gradient in order to facilitate the movement of the wagons.

Good results are generally obtained by having as profile of the lines first a descending gradient of 20 to 30 or 35 per mil from the top of the saddle-back, and then about 40 metres (44 yards) of a 15 per mil gradient to the switches of the sorting sidings, the latter being about 200 to 300 metres (219 to 328 yards) long and having a gradient of 4 to 5 per mil.

If the sorting sidings are on a long continuous incline, the sorting and marshalling of the wagons is much facilitated; this is the system very generally adopted in England, where Edge Hill goods yard is a typical instance of such an installation.

We can also mention the following cases in France and Germany, where the goods yards are on continuous inclines without saddle-backs :

FRANCE.

Terrenoire, on the Paris-Lyons-Mediterranean Railway. A long continuous incline of about 14 per mil, extending from one end of the yard to the other.

GERMANY.

Nuremberg, gradient of 5 to 16 per mil on the reception sidings, of 12·5 per mil at the switches of the sorting sidings, of 5 per mil on the sorting sidings.

Dresden-Friedrichstadt, gradient of 10 per mil.

*

The use of gridirons for the sorting sidings has a tendency to become general. Sometimes there is only one gridiron, sometimes there are two, one after the other.

Sometimes the wagons descend by gravity on a continuous incline, passing over the sorting sidings and marshalling sidings to the departure sidings, as at Dresden, Nuremberg and Strasburg; sometimes the wagons are hauled by a locomotive from the sorting sidings up to a saddle-back from which they run on to the marshalling sidings, as at Mannheim and at Lumes.

Whether a saddle-back or a continuous incline is used for the sorting sidings or for the marshalling sidings appears to be in reality determined by the local topographical conditions. The saddle-back system will accordingly be the more convenient in most cases.

When there is a continuous incline, one is led to carry out all the sorting operations in one and the same direction, for all the different lines terminating at the yard. The reception sidings for all the lines are grouped together at one end A, the departure sidings at the other end B, and all the wagons are sorted in the direction A to B.

The wagons on lines terminating at one end of the station thus as a rule make an unnecessary journey at their arrival and at their departure.

At saddle-back yards on the other hand it is possible, when the traffic is sufficiently important, as at Mannheim, to have two series of sidings laid side by side, each for the wagons arriving at the opposite ends of the station; these are then sorted in two opposite directions.

---

b) What system is adopted for stopping and again starting the cars in the two cases mentioned above (hand brakes, sprags, skids, etc.)?

Are all the cars which are shunted at yards with continuous inclines, fitted with hand brakes? How is the work carried out when this is not the case?

In England, practically all the wagons are fitted with brakes, and sprags and skids are only used very exceptionally. In other countries, the most usual method for stopping wagons is the use of skids.

A special form of skid or rail-brake (*Gleisbremse*) is rather extensively used in Germany. This skid is placed a little below the top of the saddle-back; its object is to reduce the speed of certain sets of wagons which otherwise might become accelerated too much. This skid has limited travel; that is to say, at a given point there is a special device which throws the skid off while the wagons continue their journey (1). A skid of this type is also used on the French Eastern, at the Lumes sorting yard. The use of such a rail-brake makes it possible to give the saddle-back

(1) See *Bulletin of the Railway Congress*, 1909, p. 3042.

the gradient necessary for the most unfavourable conditions of rolling, especially when there is a strong head wind. When there is a calm or when the wind comes from behind, the speed of the wagon or set of wagons is reduced by means of this rail-brake before the switches of the sorting siding are reached.

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c) *What arrangements are adopted for stopping run-aways (chain drags, safety sidings, sand tracks, etc.)?*

The arrangements seem to be very little used and only applied in very exceptional cases.

The London and North Western Railway states that the chain drag which in in use at Edge Hill, near Liverpool, has given excellent results; it has already come into operation more than two hundred times without a failure.

2° *Have you adopted any arrangement of tracks making it possible to eliminate any interruption of the shunting, sorting and making up operations owing to the arrival and departure of trains?*

All the railway administrations agree in recognizing the great interest there is in realizing this condition. It results in a saving in working expenses in consequence of a better utilization of the shunting locomotives and of the staff, and there is also a saving in the time during which the wagons which are to be sorted have to stand still. Consequently, the reception sidings are less encumbered, and their number can accordingly be reduced.

But local conditions do not always make it possible to carry out this programme fully.

3° *What importance do you attach to the realization of the different preceding conditions (continuity and uniform direction of movement, elimination of all interruption to shunting operations)?*

Does the advantage obtained by this realization justify, to the same extent in each case, the large size to be given to the yards and the resulting expense?

It is generally thought that when a new yard is in question, which is to accommodate a very large amount of traffic, the realization of these conditions is of sufficient importance to justify the large expenditure involved. But for this it is necessary, as already stated, that there should be a very large amount of traffic; if this is not the case, the great length the yard is bound to have owing to the arrange-

ment of the different sidings (reception sidings, sorting sidings, marshalling sidings, departure sidings), not only involves a large capital expenditure, but also makes it necessary to have a large operating staff. The administration of the Bavarian State Railway thinks that such extensive installations are advisable ;

a) If at least 4,000 wagons are dealt with per day;

b) If the sorting has to be effected for a large number of stations in a large number of different directions; and if, moreover, the work cannot be divided between various yards and if long-distance goods trains cannot be organized.

This administration thinks that although very economic results are obtained with this system at Nuremberg where 4,200 wagons are dealt with every day, this is probably not the case at Aschaffenburg, where there are only 2,300 wagons per day.

At the older sorting yards, the conditions enunciated are generally not satisfied, and could not be realized without excessive expenditure on account of local hindrances and of the difficulty of giving these yards such a large extension.

Thus there are a number of French sorting yards where there is only one large sorting gridiron with a saddle-back and waiting and departure sidings at each end. The sorting and marshalling operations are carried out at each saddle-back.

The result is that it is necessary to interrupt the sorting operations at one or the other saddle-back each time a train made up on a track of the sorting siding starts.

4° *Please enclose in your answer plans of the yard or yards best satisfying the two conditions* 1° *and* 2° *above. Please also state what area is occupied by these yards, what the total length of track is, and how many cars are dealt with every twenty-four hours; each car arriving at the yard to be counted as one unit only.*

We give below, together with some particulars supplied to us by the different railway administrations, a list of the stations described as best satisfying the two conditions previously mentioned; namely :

1° Continuity and uniform direction of movement during shunting operations ;
2° Elimination of all interruption to shunting operations.

GERMANY.

Brockau yard, Silesia.

Area : 87·9 hectares (217·21 acres).

Length of track, main-lines	11·750 kilometres	(7·301 miles).
Subordinate lines	87·852 —	(54·590 —).
Total. . .	99·602 kilometres	(61·891 miles).

420 switches.
4 block-system signal cabins.
11 shunting cabins.
7 traversers.
4 saddle-backs.
5,500 wagons per twenty-four hours, at busy times 6,500.

Wilhelmsburg yard, near Hamburg.

Area : 55·4 hectares (137·40 acres).
Length of yard : 2·770 kilometres (1·721 miles).

Length of track, main-lines	10·650 kilometres	(6 618 miles).
Subordinate lines	31·710 —	(19·704 —).
Total. . .	42·360 kilometres	(26·322 miles).

240 switches.
3 block-system signal cabins with 57 levers.
3 shunting cabins with 67 levers.
10 switching stations with 129 levers.
5,500 wagons per day.

Rothenburgsort yard, near Hamburg.

Area : 41 hectares (101·32 acres).
Length of yard : 2·440 kilometres (1·516 miles).

Length of track, main-lines.	7·0 kilometres	(4·350 miles).
Subordinate lines	49·5 —	(30·758 —).
Total . .	56·5 kilometres	(35·108 miles).

5 saddle-backs and 1 rail-brake.
255 switches.
5 block-system cabins with 89 levers.
12 switching stations with 145 levers.
1,800 wagons per twenty-four hours.

Hausbergen yard, near Strasburg.

Area : 94 hectares (232·29 acres).
Length of station : 4 kilometres (2·486 miles).
Length of track : 85 kilometres (52 818 miles).
7 block-system cabins with 66 signal levers, 75 route levers and 298 switch levers.
4,500 wagons per twenty-four hours.
Capital cost : 23 million francs (£920,000).

*

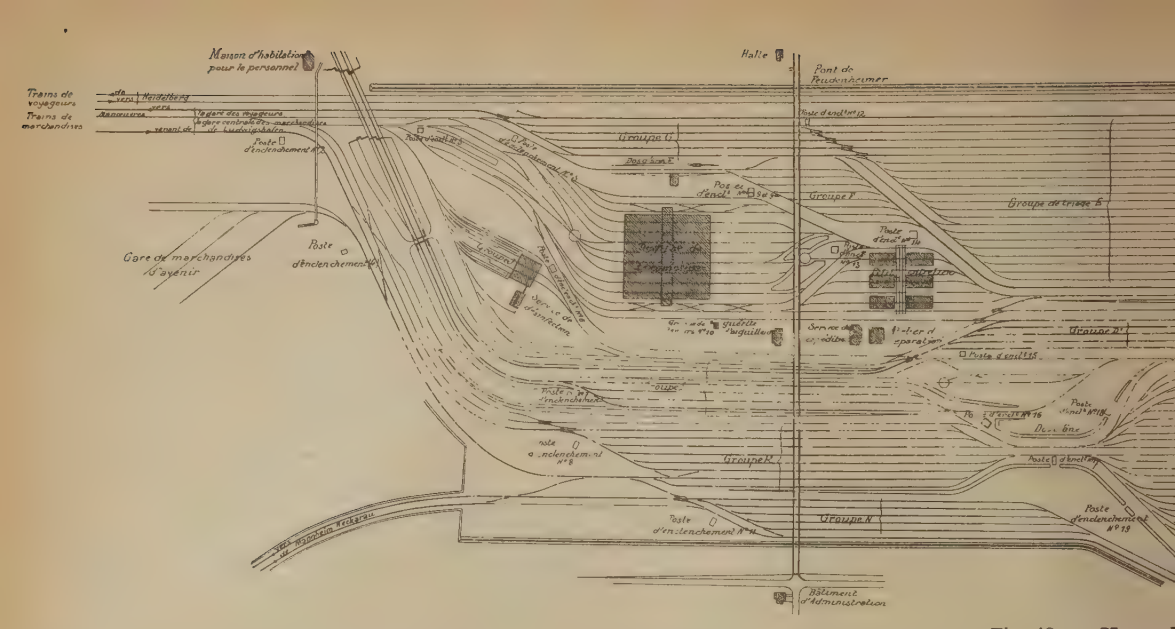
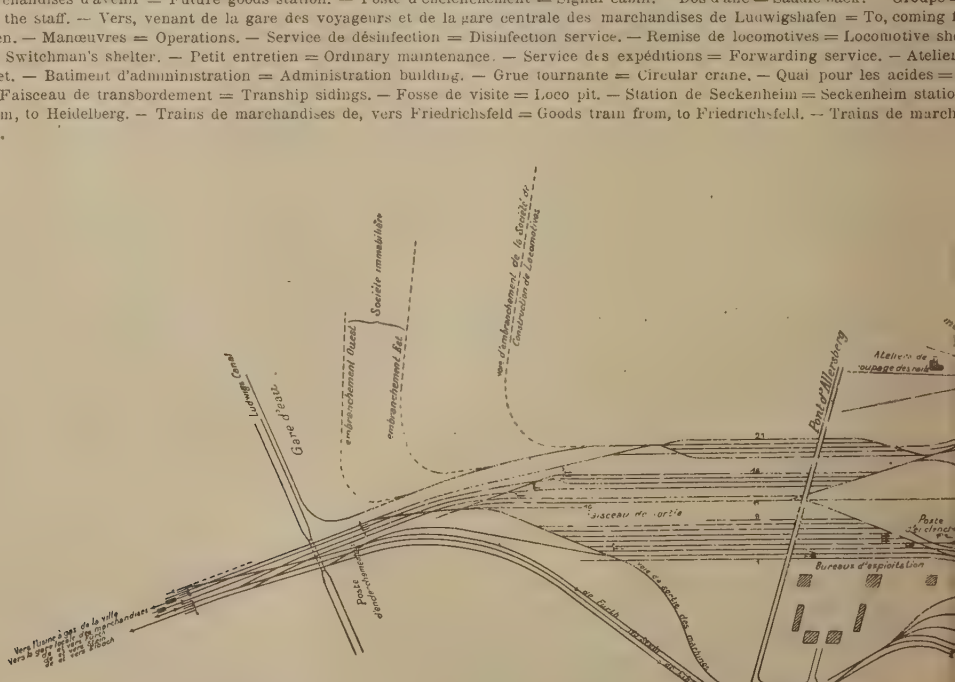


Fig. 12. — **New sh**

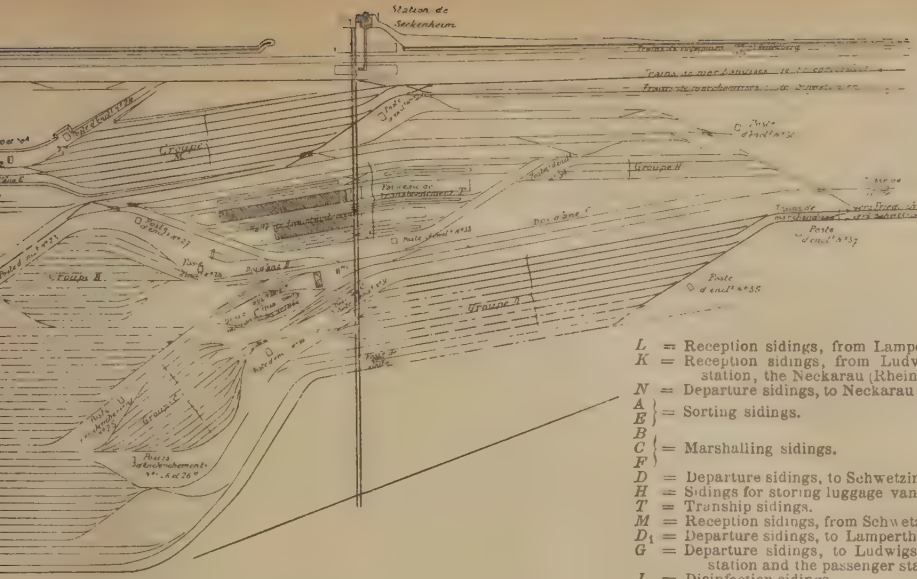
Explanation of French terms of figure 12 : Halte = Stopping place. — Pont de Feudenheimer = Feudenheimer bridge. — Trains de voyageurs = Passenger trains. — Gare de marchandises d'avenir = Future goods station. — Poste d'enclenchement = Signal cabin. — Dos d'âne = Saddle-back. — Groupe = = Dwelling house for the staff. — Vers, venant de la gare des voyageurs et de la gare centrale des marchandises de Ludwigshafen = To, coming f station at Ludwigshafen. — Manœuvres = Operations. — Service de désinfection = Disinfection service. — Remise de locomotives = Locomotive sh Guérite d'aiguilleur = Switchman's shelter. — Petit entretien = Ordinary maintenance. — Service des expéditions = Forwarding service. — Atelier de triage = Sorting set. — Batiment d'administration = Administration building. — Grue tournante = Circular crane. — Quai pour les acides = Tranship building. — Faisceau de transbordement = Tranship sidings. — Fosse de visite = Loco pit. — Station de Seckenheim = Seckenheim statio = Passenger train from, to Heidelberg. — Trains de marchandises de, vers Friedrichsfeld = Goods train from, to Friedrichsfeld. — Trains de march from, to Schwetzingen.



The Nuremberg shunting yard is on a continuous incline extending from the reception sidings to the departure sidings. First come the reception sidings, then the sorting sidings, and then the marshalling sidings, forming a gridiron. From the latter the wagons are taken in the order desired to the departure sidings where the train is completed.

It is only when there is a strong head wind or when it snows, that the wagons are taken from the reception sidings up the saddle-back in order to give them the necessary velocity.

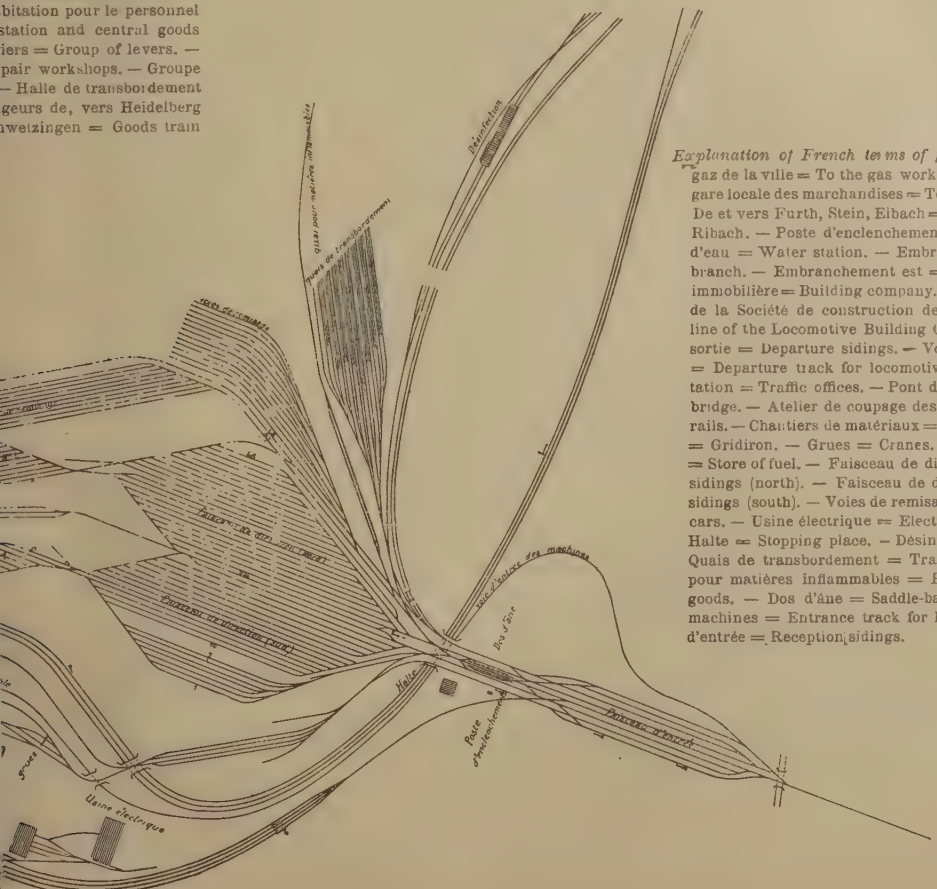
Fig. 13. — **Sh**



L = Reception sidings, from Lampertheim.
K = Reception sidings, from Ludwigshafen, the Central goods station, the Neckarau (Rheinau) passenger station.
N = Departure sidings, to Neckarau and the future goods station.
A, E = Sorting sidings.
B, C, F = Marshalling sidings.
D = Departure sidings, to Schwetzingen and Friedrichsfeld.
H = Sidings for storing luggage vans.
T = Transhipping sidings.
M = Reception sidings, from Schwetzingen and Friedrichsfeld.
D_1 = Departure sidings, to Lampertheim.
G = Departure sidings, to Ludwigshafen, of the Central goods station and the passenger station.
J = Disinfection sidings.

at Mannheim.

e marchandises = Goods
bitation pour le personnel
station and central goods
iers = Group of levers. —
pair workshops. — Groupe
— Halle de transbordement
geurs de, vers Heidelberg
nweizingen = Goods train



Explanation of French terms of figure 13: Vers l'usine à gaz de la ville = To the gas works of the town. — Vers la gare locale des marchandises = To the local goods station. — De et vers Furth, Stein, Eibach = To and from Furth, Stein Ribach. — Poste d'enclenchement = Signal cabin. — Gare d'eau = Water station. — Embranchement ouest = West branch. — Embranchement est = East branch. — Société immobilière = Building company. — Voie d'embranchemen de la Société de construction de locomotives = Private line of the Locomotive Building Company. — Faisceau de sortie = Departure sidings. — Voie de sortie des machines = Departure track for locomotives. — Bureaux d'exploitation = Traffic offices. — Pont d'Allersberg = Allersberg bridge. — Atelier de coupage des rails = Shop for cutting rails. — Chantiers de matériaux = Store of materials. — Gril = Gridiron. — Grues = Cranes. — Dépôt de combustible = Store of fuel. — Faisceau de direction (nord) = Sorting sidings (north). — Faisceau de direction (sud) = Sorting sidings (south). — Voies de remisage = Siding for keeping cars. — Usine électrique = Electric generating station. — Halte = Stopping place. — Désinfection = Disinfection. — Quais de transbordement = Transhipping platform. — Quais pour matières inflammables = Platform for inflammable goods. — Dos d'âne = Saddle-back. — Voie d'entrée des machines = Entrance track for locomotives. — Faisceau d'entrée = Reception sidings.

Nuremberg.

Mannheim yard.

(See fig. 12.)

Area : 218 hectares (538·70 acres).
Length of track : 153·400 kilometres (95·320 miles).
Length of yard : 4·500 kilometres (2·796 miles).
36 signal cabins.
8,000 wagons per twenty-four hours.
Cost : 22,500,000 francs (£900,000).

Nuremberg yard.

(See fig. 13.)

Area : 105 hectares (370·67 acres).
Length of track : 110 kilometres (68·352 miles).
4,200 wagons per twenty-four hours.

Aschaffenburg yard.

Area : 15 hectares (37·07 acres).
Length of track : 28 kilometres (17·395 miles).
2,300 wagons per twenty-four hours.

Wurzburg-Zell yard.

Area : 60 hectares (148·27 acres).
Length of track : 30 kilometres (18·641 miles).
From 1,500 to 1,700 wagons per twenty-four hours.

Unterturkheim yard (Wurtemberg

Area : 18·3 hectares (45·22 acres).
Length of track : 27·8 kilometres (17·274 miles).
2,500 wagons per twenty-four hours.

Osterfeld yard, near Essen

Area : 49·9 hectares (123·31 acres).
Length of yard : 3·750 kilometres (2·330 miles).

Length of track, main-lines	11·280 kilometres	(7·009 miles).
Subordinate lines	85·270 —	(52·985 —
Total . . .	96·550 kilometres	(59·994 miles).

6,655 wagons per twenty-four hours.

Engelsdorf yard, near Leipzig.

Area : 36·6 hectares (90·44 acres).
Length of track : 62·490 kilometres (38·830 miles).
2,500 wagons per twenty-four hours.

GREAT BRITAIN.

Dunford and Wath yards (Great Central Railway).
Temple Mills yard (Great Eastern Railway).

6,000 wagons per twenty-four hours.

FRANCE.

Pantin-Bobigny yard (French Eastern Railway).

Area : 35 hectares (86·49 acres).
Length of track : 35·130 kilometres (21·829 miles).
2,200 wagons per twenty-four hours.

Lumes yard, near Charleville (French Eastern Railway).

(See fig. 14.)

Area : 55 hectares (135·91 acres).
Length of track : 38·500 kilometres (23·923 miles).
2,000 wagons per twenty-four hours.

Terrenoire yard (Paris-Lyons-Mediterranean Railway).

1,060 wagons per twenty-four hours.

Juvisy yard (Orleans Railway).

Area : 30 hectares (74·13 acres).
2,000 wagons per twenty-four hours.

Lumes shunting yard is near the banks of the Meuse, an
It has direct connections with the five iron roads wh
The installations include :
1. A set of 12 reception sidings, 600 mètres (656 yards
2. A large set of sorting sidings ; the Charleville end
other end, connected with two draw-out tracks, is utilize
This set consists of 31 sorting sidings, enclosed on th
waiting to start.
These sidings vary in length from 550 to 670 mètres (
3. A set of marshalling sidings for road trains, place
the opposite end to the saddle-backs of the sorting siding
Two running lines in each direction are outside thes
The transhipment installations are on the Longuyon sid
of sidings for finished trains waiting to start.

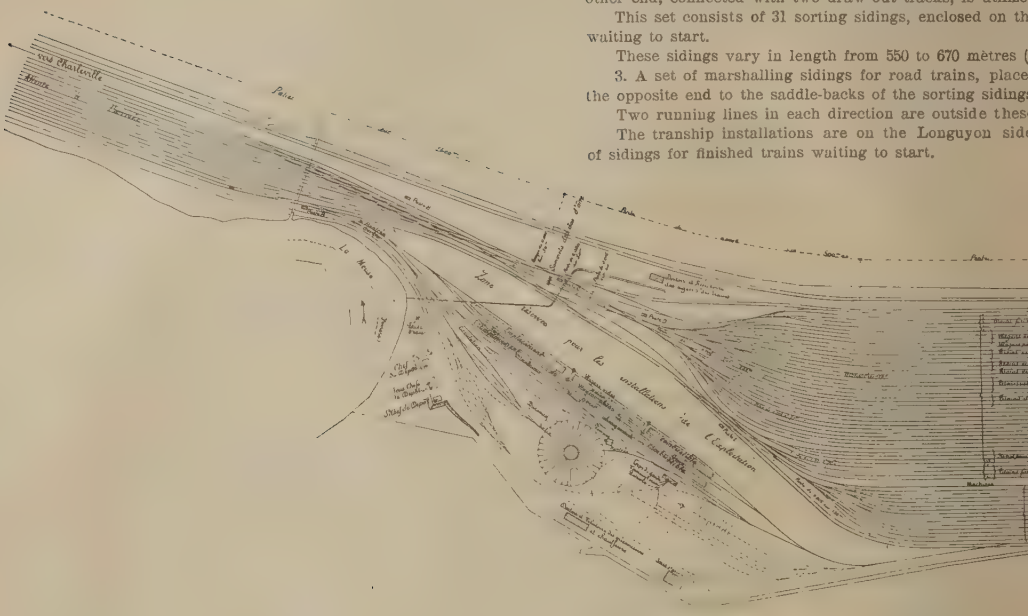


Fig. 14. —

Explanation of French terms : Attente à l'arrivée = Reception sidings. — Palier sur 1,600 mètres ; pente de 0.0006 sur 500 mètres : pente
900 metres (984 yards) ; level, 1,200 metres (1,312 yards). — Poste = Signal cabin. — Rentrée = Entry. — Sortie = Departure. — P
sur 50 mètres = Rising gradient of 10 per mil over 50 metres (55 yards). — Sommets du dos d'âne = Top of saddle-backs. — Pent
over 40 metres (44 yards). — Dortoir et réfectoire des agents des trains. = Sleeping quarters and dining room of train staff. —
Bureaux = Offices. — Dortoir et réfectoire des mécaniciens et chauffeurs = Sleeping quarters and dining room of locomotive sta
wagons. — Wagons pleins = Loaded wagons. — Emplacement = Plan. — Machines en chargement = Locomotives being loaded.
over 70 metres (77 yards). — Pente de 0·002 sur 70 mètres = Falling gradient of 2 per mil over 70 metres (77 yards). — Pente
over 100 metres (109 yards). — Rampe de 0·002 sur 70 mètres = Rising gradient of 2 per mil over 70 metres (77 yards). — Rampe
de désinfection = Disinfection establishment. — Rampes de 0·015 sur 40 et de 0·002 sur 30 mètres ; pente de 0.015 sur 60 mètres = R
Pente de 0·0063 = Falling gradient of 6·3 per mil. — Débranchement = Sorting. — Classement = Marshalling. — Machines = Loco
Raccordement des usines de Flize = Junction line to Flize works. — Voie de sécurité = Safety sidings. — Ancienne Ballastière =
Trains formés pour Charleville et Mohon = Trains marshalled for Charleville and Mohon. — Trains formés pour Longuyon, Long
wagons. — Trains vers Reims = Trains to Reims. — Trains vers Hirson = Trains to Hirson. — Trains vers Givet = Trains to
trains for lines 2, 5 and 7.

5° *Please describe the appliances you use for handling goods :*

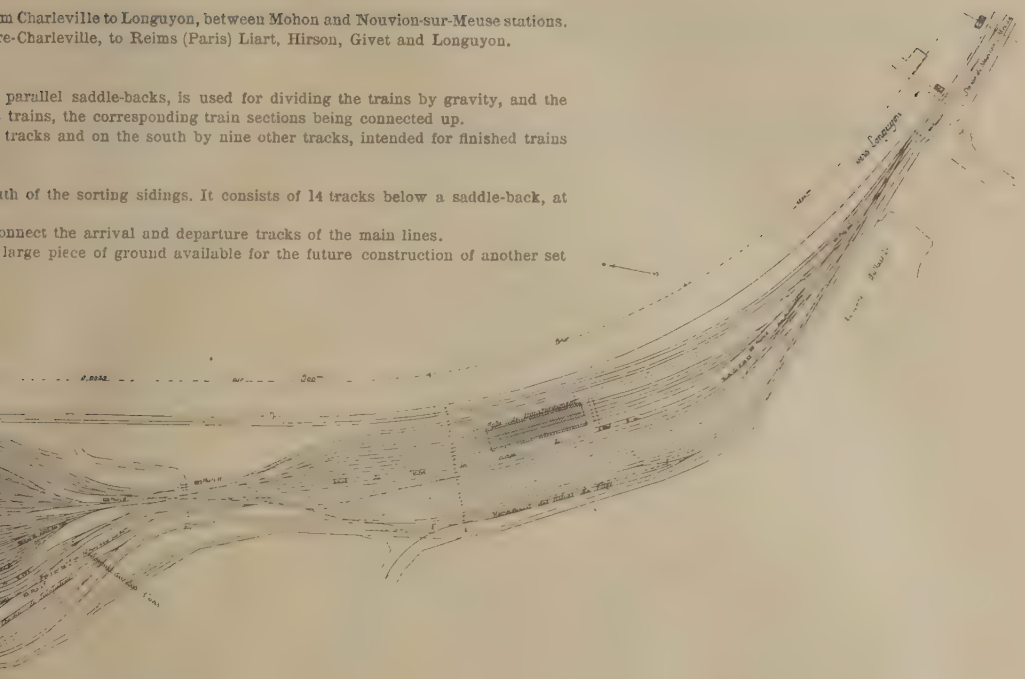
a) At yards where there is one floor only (capstans, cranes, transporters, etc.);

m Charleville to Longuyon, between Mohon and Nouvion-sur-Meuse stations.
re-Charleville, to Reims (Paris) Liart, Hirson, Givet and Longuyon.

parallel saddle-backs, is used for dividing the trains by gravity, and the
trains, the corresponding train sections being connected up.
tracks and on the south by nine other tracks, intended for finished trains

uth of the sorting sidings. It consists of 14 tracks below a saddle-back, at

onnect the arrival and departure tracks of the main lines.
large piece of ground available for the future construction of another set



at Lumes.

res ; palier de 1,200 mètres = Level, 1,600 metres (1,750 yards) ; gradient of 0·6 per mil, 500 metres (546 yards) ; gradient of 2·0 per mil,
rane. — Rivière = River. — Chef de dépôt = Yard master. — Sous-chefs de dépôt = Assistant yard master. — Rampe de 0,01
es = Falling gradient of 20 per mil over 50 metres (55 yards). — Pente de 0,015 sur 40 mètres = Falling gradient of 15 per mil
mil over 220 metres (240 yards). — Zone réservée pour les installations de l'exploitation = Zone reserved for working installations.
trique = Electric substation. — Sortie = Exit. — Entrée = Entry. — Voie de la grue = Track for crane. — Wagons vides = Empty
el. — Corps de garde ; lampisterie ; pétrole = Lampmen ; petroleum. — Pente de 0.003 sur 70 mètres = Falling gradient of 3 per mil
es = Falling gradient of 5 per mil over 158 metres (173 yards). — Rampe de 0.002 sur 100 mètres = Rising gradient of 2 per mil
es = Rising gradient of 2 per mil over 100 metres (109 yards). — Rampe de 0.002 par mil = Rising gradient of 2 per mil. — Chantier
er mil over 40 metres (44 yards) and of 20 per mil over 30 metres (33 yards ; falling gradient of 15 per mil over 60 metres (66 yards). —
ransbordement = Transhipping shed. — Voies de tiroir en rampe de 0.001 par mètre = Draw out tracks, rising gradient of 1 per mille. —
mes pour Charleville et Mohon et raccordements particuliers = Train sections for Charleville and Mohon and special connections. —
ns marshalled for Longuyon, Longwy and Conflans. — Wagons vides = Empty wagons. — Wagons pour transbordement = Transhipping
Longuyon, Longwy et Conflans = Trains to Longuyon, Longwy and Conflans. — Trains de détails pour les lignes 2, 5 et 7 = Road

Circular cranes and travelling cranes are very generally used where goods are unloaded. Inside covered premises, in France, the cranes known as Nepveu cranes are frequently used, which run on overhead rails at right angles to the tracks; the

bottom end is supported on the surface of the ground. These appliances are generally operated by hand.

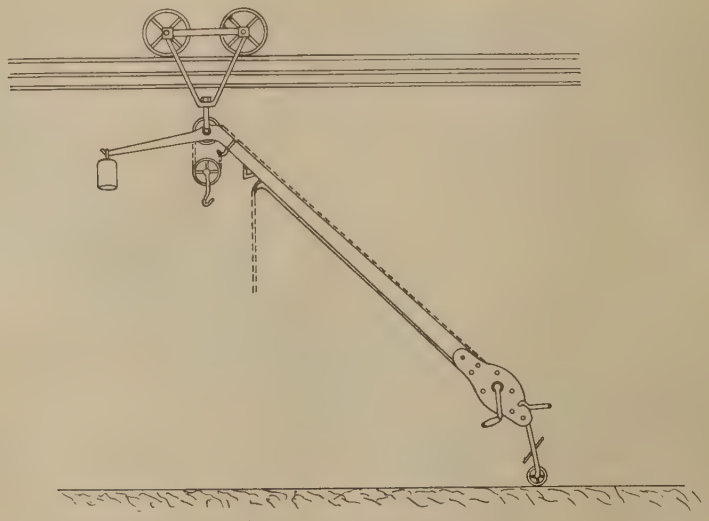


Fig. 15. — Nepveu crane.

Steam or electric traversers are also used at many yards.

Finally the use of electric capstans, with return barrels, tends to become and more general for moving the wagons about on sidings and turn-tables. These capstans were at first designed to develop a maximum tractive effort of 800 kilograms (1,760 lb); now they are generally designed for one of 1,000 to 1,100 kilograms (2,200 to 2,425 lb.). This not only enables longer train-sections to be operated, but makes the starting certain, even if the track is in bad condition, or is covered by sand or mud, as sometimes happens at very busy stations. The capstans can be of two different types : direct acting, when the electric motor is fixed direct to the shaft of the barrel, or indirect, when the motor acts on that shaft through gearing. The direct-acting type, which is only used when the electric energy is supplied in the form of continuous current, allows the barrel, when the current is cut off, to turn in either direction and so makes return movements possible. This may be of advantage if the wagons, by virtue of the speed acquired, run beyond the capstan. This type of capstan also seems to act more gently on the rope, which will consequently become less worn. But present experience does not yet enable us to be certain on this point. The wear of the rope is moreover one of the most important factors affecting the cost of operation of the capstan. A compound rope, that is to say a rope made of steel wire laid round a hemp core, appears to give the best result.

b) At yards where there are several floors (cranes, lifts, travelling endless belts, mechanically operated trucks, etc.).

Many yards with several floors are to be found in England: they also commence to be used at several large French yards. Special instances are the Paris Ivry and the Bordeaux Bastide yards on the Orleans Railway.

The New Bridge goods yards at Newcastle (North Eastern Railway) deserve special mention.

The building is made entirely of reinforced concrete and includes a basement, a ground floor, two upper floors and a terrace. The equipment includes 1-ton electric cranes, a wagon hoist which can raise 20 tons and lower 30 tons, 1-ton lifts, capstans and an electric traverser. The electric cranes are suspended cranes which in addition to their movement of rotation can be displaced transversely along rails; these rails are fixed to a rolling bridge. Thus the field of operations of these cranes is extensive. In the basement, in addition to cranes similar to those just described, there are two cranes revolving about pillars, at the bottom on a rolling path made on the ground, at the top on a rolling path hung from the ceiling.

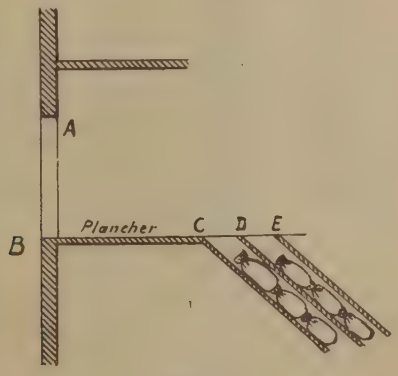


Fig. 16.

Explanation of French term : Plancher = Floor.

This yard also has a storehouse for corn, where the sacks are stored in inclined corridors. They are brought by means of electric cranes through the windows AB and taken to CD, DE, where there are the traps giving access to the corridors. These corridors are very numerous and arranged in such a way at the bottom that an employee can, by operating the appropriate traps, load a wagon with sacks coming from any given group of corridors.

Among the electric equipment of such buildings having several stories, we may also mention a barrel-lift which is in use at the Paris Ivry station (Orleans Railway).

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and gives very good results. This barrel-lift, of which we give a general view and also details, consists of an endless chain operated electrically, which carries at intervals supports, formed of a kind of comb, the teeth of which are of an angular shape ABC.

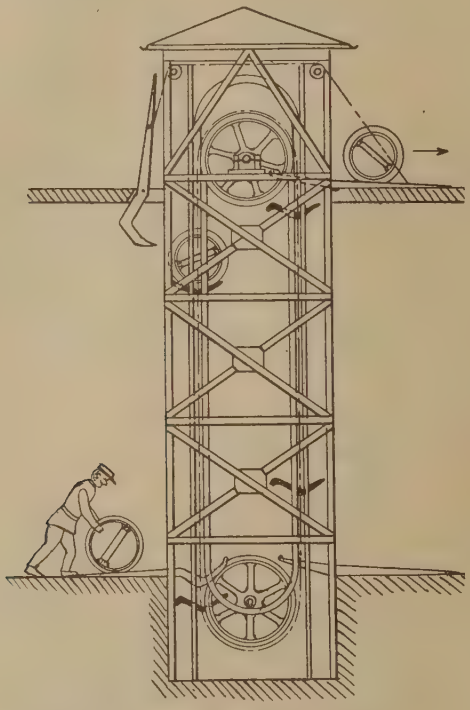

Fig. 17. — Continuous barrel-lift. General view.

The barrel is brought to the end of a platform EF which also has teeth, corresponding to the empty spaces in the combs ABC. As it travels, the comb ABC passes through the platform end and raises the barrel which has been placed there. Two arms BG and BH which are fixed to the comb, ensure its guidance, so that it takes a movement of translation. With this object in view, the roller G follows a groove formed by two vertical parts connected at the top and bottom by semicircles; the roller H also follows a circular groove at the top and bottom, namely at those places where the guidance of the one roller G would not suffice.

This lift has a considerable capacity; it provides from 80 to 100 empty spaces per hour. It can also be used for packages of all kinds, provided their shapes and dimensions are within the limits determined for each given type.

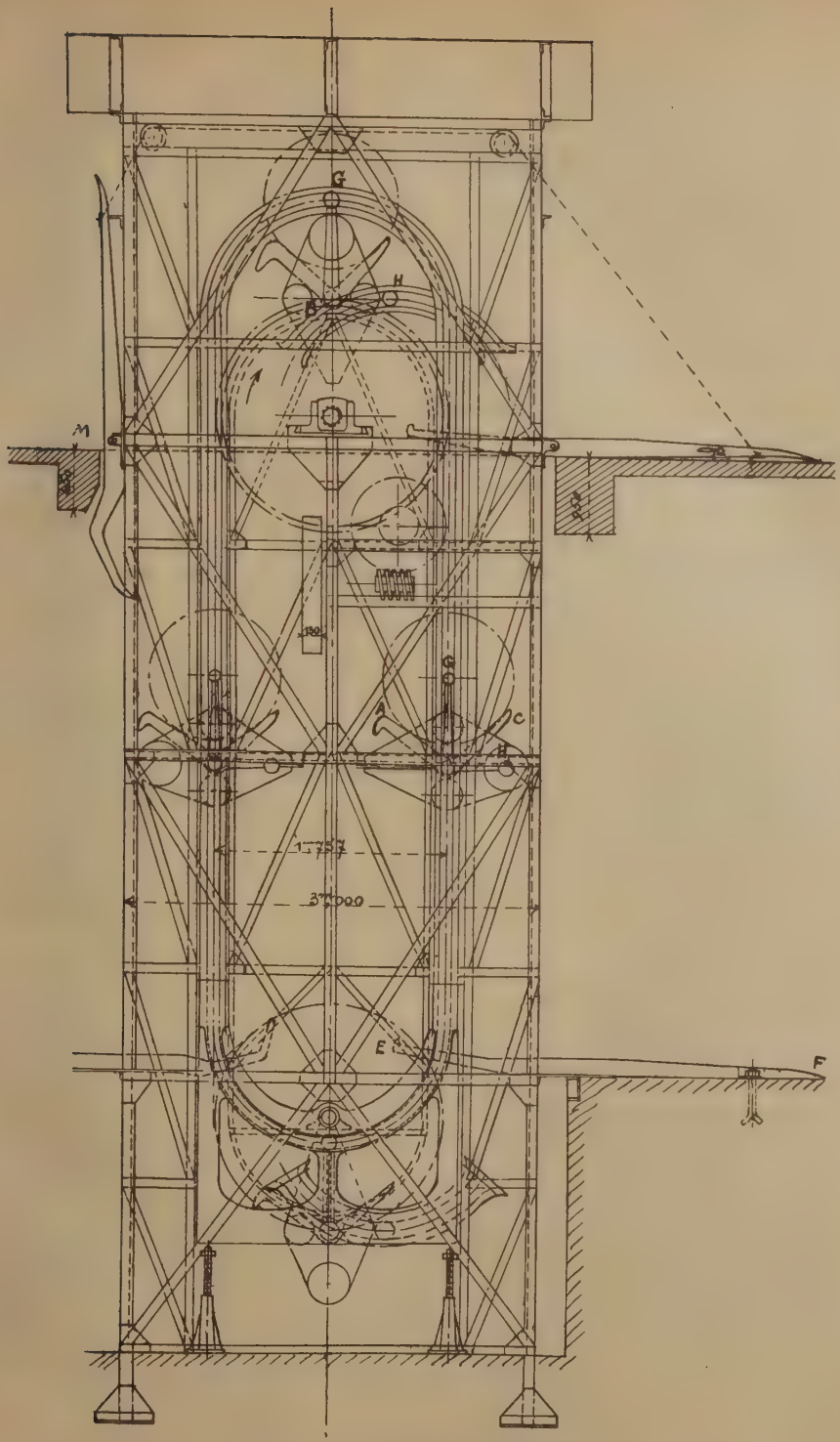

Fig. 18. — Continuous barrel-lift. Details.

Finally, we will mention the mechanical sorting of the parcels despatched from Paris-Austerlitz station by means of endless belts and shoots which has been described in detail in the February and March 1902 numbers of the *Revue générale des chemins de fer*.

CONCLUSIONS.

Large passenger stations.

The preceding information leads us to conclude, as regards large passenger stations, that in order to obtain the maximum working capacity, combined with safety of working, it is advisable in the first place to divert from them everything connected with the local goods and parcels services. It is equally advisable to concentrate the suburban service on certain tracks which are in principle reserved for it; but to utilize at certain hours or on certain days, where one of the two traffics, suburban or main line, becomes of preponderating importance, either the main lines for the suburban service, or the suburban lines for the main-line service. The establishment of large scissors crossings at the entrance of stations which makes it possible to receive a train coming from any direction on any of the tracks tends to become general and seems to be an excellent means for increasing the working capacity. The use of power-operated signals and switches, which can be set easily and quickly, and the use of which tends to become general, makes it possible to utilize these connections under the best conditions. It is finally an advantage to have in front of the different platforms tracks making it possible to change locomotives quickly or to alter composition of trains quickly. A set of marshalling sidings near the station, and connected with it by independent tracks, is also a very useful addition to the installation.

When the local conditions allow it, it is as a rule of advantage to adopt either the type of a station with floors, or the type of mixed station, that is to say including tracks at two different levels. The ground is then utilized better, the passengers can be more easily distributed among the various platforms, and the luggage service can be carried out with much less inconvenience to the passengers.

The use of mechanical appliances for handling the luggage is much to be recommended, and, at stations with floors, the use of elevators to save the public the mounting of stairs, appears to be an important improvement, particularly when those elevators are of the continuous-action type.

It has to be added that it is rather exceptional to have to build a whole new large passenger station. It is much more usual to have to modify or enlarge an existing station; one is then hindered by local difficulties from applying the principles we have expounded, except to a limited extent.

Large goods yards.

Shunting yards, on the contrary, can as a rule be built in the open country and constructed to suit the purpose they are intended for, without having their design influenced by local conditions foreign to the working conditions of lines which are to be provided for.

Such yards, it seems, should in all cases include three sets of sidings for : the standing after the entry, for the sorting and finally for the marshalling and standing before the start, of the trains to be dealt with. The length of those sidings depends on the length of the trains, and their number, on the density of the traffic.

When the yards have to provide for a very busy traffic, other sidings of less importance are added for the geographical sorting.

Finally these can all be doubled, so as to have two distinct complete sets, one for the one direction and the other for the other.

It is a great advantage to arrange these different sets as well as the running lines, in such a way as to obtain a continuity of movement in the shunting operations and to eliminate any interruption of these operations owing to the arrival or departure of trains.

Shunting yards cannot practically be built with a continuous incline unless the ground has a natural slope; and in most cases it appears preferable to have saddle-backs. The skid seems to be the best appliance for stopping wagons.

The mechanical handling of the goods or wagons in the buildings and near the buildings, by means of hand cranes or electric cranes, of electric capstans, of lifts, etc., tends to become developed and constitutes an important improvement. It results in the more frequent use of buildings with several floors.

[656 .211 & 656 .212]

REPORT N° 3

(America)

By H. A. JAGGARD,

SUPERINTENDENT, PENNSYLVANIA RAILROAD.

Questions were sent to thirty-seven American railroads. In the selection of the roads to be interrogated effort was made to take such roads as were known to have made progress in the directions indicated. Replies were received from the following roads :

Argentine Republic.

Buenos Aires Great Southern Railway.
Buenos Aires & Rosario Railway.

Canada.

Grand Trunk Railway.

United States.

Atchison, Topeka & Santa Fe Railway.
Atlantic Coast Line Railroad.
Baltimore & Ohio Railroad.
Baltimore & Ohio Southwestern Railroad.
Boston & Albany Railroad.

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Chicago & Alton Railroad.
Chicago, Burlington & Quincy Railroad.
Chicago, Milwaukee & St. Paul Railway.
Chicago & North Western Railway.
Chicago, Rock Island & Pacific Railway.
Chicago & Western Indiana Railroad and the Belt Railway of Chicago.
Cleveland, Cincinnati, Chicago & St. Louis Railway.
Delaware & Hudson Company.
Denver & Rio Grande Railroad.
Erie Railroad.
Illinois Central Railroad.
Lake Shore & Michigan Southern Railway.
New York Central & Hudson River Railroad.
Northern Pacific Railway.
Pennsylvania Lines West of Pittsburgh.
Pennsylvania Railroad.
Philadelphia & Reading Railway.
Pittsburgh & Lake Erie Railroad.
Southern Pacific Railroad.
St. Louis & San Francisco Railroad.
Union Pacific Railroad.

Uruguay.

Central Uruguay Railway of Montevideo.

The data and conclusions set forth herein rest chiefly on the information thus obtained.

A. — CONCERNING LARGE PASSENGER STATIONS.

Question 1. — *Have you adopted any special arrangements in order to increase the working capacity of your stations and to insure the safety of the shunting operations?*

Much thought has been given to this problem. It has been forced upon railroads and terminal companies by the rapid growth of cities, such as Boston, New York, Philadelphia, Washington, Pittsburgh, Chicago, St. Louis, and others. Various solutions or partial solutions have been reached. The question is intimately associated with the development of electrical systems of movement, whether by electric locomotives or by the multiple unit system.

The condition of some of the roads (more especially in the West and South, where

the population is less concentrated) is indicated by the answer of the Chicago, Burlington & Quincy Railroad :

No. The conditions under which passenger traffic is handled on the Chicago Burlington & Quincy Lines is entirely different from that to which the questions herein given apply. On the Burlington Lines the larger percentage of the business is freight; and while doing a large passenger business for its territory, it is at no point so congested as to call for special passenger handling facilities.

The Union Pacific Railroad says :

Aside from the use of slip switches ond two leads at each end of a group of 6 to 8 tracks, we have not adopted any special arrangement, but have made designs which require the handling of baggage by means of subways, with elevators to carry the baggage to the track level, which, to a certain extent, reduces switching. We have also made designs having the passenger tracks in pairs, with subways for the passengers to reach the platforms between the tracks without crossing them, thus saving considerable switching.

QUESTION 1-*a*. — *Are the tracks for main line trains grouped together in a set separate from the set of tracks used for suburban trains ?*

The general answer to this question is " No ". Suburban traffic on a large scale is a comparatively late development in many localities. It appeared too late to affect designs made twenty-five to forty years ago. In designs of this date, however, the Operating Departments have adapted the use of old track lay-outs to effect more or less of a separation. Many modern stations, however, show a separation of suburban traffic from through, or main line, traffic. The most complete illustrations reported are found in the new 42nd Street Station of the New York Central & Hudson River Railroad, in New York City, and the New York Terminal Station, Pennsylvania Railroad. The Union Station, Washington, illustrates the same principle.

QUESTION 1-*b*. — *Are the suburban tracks arranged so as to reduce shunting operations to a minimum ? Have you, for instance, adopted, as the solution, and loops at certain stations, as at Boston Station (U. S. A.) ?*

The new 42nd Street Station of the New York Central & Hudson River Railroad in New York City shows the use of the loop solution worked out very thoroughly and consistently. The design shows :

An express level, for the handling of main line trains; on this level there are five loop tracks, which are served by three loop platforms. (Radius of the loop, 329 feet.) Inbound trains will move to the loop platforms, discharge their passengers, pass around the loop,

and move to convenient storage yards, or to passenger platforms within the loop, where they will wait until the scheduled times of departure. In this way the loop platforms handle the inbound business, and the tracks on the inside of the loop the outbound business. There are 28 outbound tracks situated within the loop, which are served by 13 platforms, including two mail and baggage platforms. In addition there are 13 storage tracks which may on occasion be used for departing tracks. These tracks have five low platforms.

A suburban level, which has four loop tracks served by three platforms, these for inbound trains. For out-bound movements there are 10 tracks with 6 platforms within the loop. The suburban level shows a 2-track loop. It is the intention to move suburban business chiefly in multiple unit cars.

By the arrangements set forth above the shunting operations are enormously reduced, as compared with the present arrangement, by which main line trains have to be moved by shifting power about five and one-half miles to the Mott Haven cleaning yards.

The New York Terminal Station of the Pennsylvania Railroad shows modern arrangements as regards reduction in shunting operations and the securing of safety. The problem here is to take care of the suburban business from Long Island and from the State of New Jersey, as well as the through business moving between New England and the South and West. The Long Island business will be cared for by platforms 1 and 2 and by tracks 1, 2, 3 and 4, on the north side of the station. The New Jersey business will be cared for by platforms 9, 10 and 11 and by tracks 16, 17, 18, 19 and 20, at the south side of the station. The through business will be handled from the middle tracks and platforms.

In the older stations, various arrangements have been adopted for reducing the shunting operations. At the South Terminal, Boston, the loop which was built some years ago is not yet in use, since the necessary electrification of outlying territory has not been completed. The track lay-out, however, is such as to permit the engine of an inbound train to cross over (after being released by having its train pulled away by another engine) and couple to the coaches of another suburban train which has recently arrived. The engine of the latter train in turn moves out a short distance, crosses over, and couples to other recently arrived coaches. The engines under this system must run tank first in one direction. They are equipped with cow catchers at both ends, and the tenders are of such construction as to allow a clear view for the engineman an fireman. The New York, New Haven & Hartford Railroad uses this method for trains within the ten-mile limit. The Boston & Albany Railroad employs this method in a zone 11 miles long. The quickness of operation is shown by the following figures :

7·38 a. m. train spots with 7·45 a. m.;
7·39 a. m. — — 7·51 a. m.;
7·45 a. m. — — 7·53 a. m.;
7·46 a. m. — — 7·55 a. m.;
7·47 a. m. — — 8·15 a. m.;
7·53 a. m. — — 8·07 a. m.; etc.

For instance, on the arrival of the 7·38 a. m. train the passengers are discharged, outgoing passengers are received, an engine from an adjacent track couples to these coaches, and the train pulls out at 7·45 a. m. The engine which brought in the 7·38 a. m. train goes out with the 7·51 a. m. train, etc. The quickest movement made by the Boston & Albany Railroad is the one in which the engine which brings in the 8·27 a. m. train takes out a train at 8·40 a. m.

The Union Station of the Terminal Railroad Association, at St. Louis, shows a unique arrangement of tracks which forms a double wye. Its advantage is thus described :

Attention is called to the general arrangement of handling passenger trains at Union Station, St. Louis, the method being to back the train into the station, and, after so doing, return on the opposite leg of wye. By this process the entire train is turned and it is set off intact in the coach yard. This method results in a great saving of damage to equipment made necessary where cars must be separated and their reverse position in train provided for when departing. I believe the Union Station at St. Louis is the only one in the country where this meihod of handling trains is persued.

Other replies follow :

Pennsylvania Railroad.

No. At Broad Street Station inbound suburban trains are utilized for outbound by permitting the locomotive and train to remain in the shed and usind the cars for trains leaving within ten minutes.

Chicago, Burlington & Quincy Railroad.

All shunting is done in a yard apart and entirely separate from the station.

Union Pacific Railroad.

We have no large stations requiring special arrangement ol tracks to expedite the changing of locomotives and cars, and none necessitating the use of end loops.

In general, the older large stations show tracks arrangements which permit quick movement from any track to any other track by double and single ladders, slip switches, etc., which command entrance to the station. This arrangement is characteristic of American practice at this time, rather than loops or special devices. With the unquestioned increase in electrification, however, the loop device will doubtless be more generally adopted.

QUESTION 1-c.— *How are the tracks arranged so as to make it possible:* I) *to change locomotives quickly;* II) *to add or take off carriages;* III) *to make up trains or bring to the platform trains made up on a special set of sidings?*

I) In the South Terminal, Boston, the track arrangement for allowing the quick changing of locomotives has already been described. The Union Station, Washington, shows for the high level track an arrangement of them in pairs, with a crossover connecting the two tracks constituting a pair. By this arrangement, a coach or parlor car which may have to be added to a train and occupy a particular position therein may be so placed by previously locating it against the bumping block; if it is determined at the last moment that it is to go in the train, a portion of the train is set over by the crossover to an adjacent track, the remainder of the train backs against the coach in question, then pulls forward, crosses over, couples to the remaining portion of the train, returns to the original track, and is reday to start.

The New York Central & Hudson River Railroad replies to questions I, II and III:

Coach yards and engine tracks as near as possible to passenger yard, and an extensive arrangement of slip switches is used to make switching movements as short as possible.

The Baltimore & Ohio Railroad replies:

c) I: Either a crossover or spur track is placed immediately ahead of where the locomotives, after pulling into the station, come to a stop. The locomotive is cut off from the train and run ahead, either on the same track or an adjoining track, or on a spur track, and the locomotive to be attached is backed down from an adjoining track to that occupied by the locomotive that has completed its run.

c) II: The same arrangement is resorted to as for locomotives, except that the lead is placed so as to clear the rear of the longest train, either by a series of crossovers or a spur track on which a shifting engine stands awaiting the arrival of the train. If the coaches are to be attached they are placed ahead of this engine and pushed up to the rear of the train immediately upon its arrival: if coaches are to be detached, the engine simply pulls in over the crossover and takes away the coaches that are to be removed.

c) III: Special coach yards are provided for cleaning and classifying, and which are accessible to the train shed or platform, each track being accessible to every other track through a series of crossovers or slip switches, or both, as may best suit the local conditions.

The Grand Trunk Railway replies:

The only means used so far is to have the tracks lead out to a general lead or ladder track, with separate switches to coach yards.

The Illinois Central Railroad reports :

Our suburban tracks of Randolph Street, Chicago, six in number, are connected at either end by a system of switches, manually handled, and engines of incoming trains are cut off immediately on arrival and moved to the roundhouse as soon as the outbound train which uses that equipment is taken off the track, which is usually in a very few minutes. Suburban trains between 7 and 10 a. m., when the inbound movements are heaviest, are drawn immediately from the station by a switch engine and stored on long tracks, without switching, as the trains remain intact and are not switched or the relative position of the different cars changed. Between 5 and 7 p. m., when the business is outbound, these trains are placed on the various tracks by a switch engine, after which the road engines are coupled on to them.

The Chicago, Rock Island & Pacific Railway reports :

I : In Chicago, which is a head-on station, when a suburban train pulls in an engine couples on to the other end and is ready to start out; then the first engine pulls on to a siding near by and couples on to the next train.

II : No provision made to add extra cars to a train at La Salle Street Station, Chicago, but arrange to do it at other places — a turntable should be built and a track for private cars.

III : Have designated certain sidings outside of the station on which trains made up are ready to back into the station at any time.

The Buenos Aires Great Southern Railway replies :

At terminal stations the tracks are arranged in pairs with crossovers enabling engines to run around other trains for a return trip within a few minutes, when necessary. Connections between these lines and the yard enable the operations mentioned in questions I, II and III to be carried out.

As stated, in the older stations the practice is to use the entering system of ladders for the movement from any one track to any other track. In stations, however, where the number of tracks exceeds a dozen, the length of the ladder is such that in certain instances the movement takes more time than the station operations can advantageously spare. A locomotive of an inbound train cannot be released, generally speaking, until its train has been pulled out of the shed, either by a shifting engine or an engine which moves the cars to the next station en route. Generally speaking, the adding or taking off of coaches is done by shifter engine, which must come from outside of the shed.

A very interesting solution of the track arrangement pertaining to Question III is found between the Sunny Side Yard, on Long Island, and the New York Terminal Station of the Pennsylvania Railroad. Here the multiple unit system equipment used for the Long Island suburban business must be moved from the station through a tunnel under East River to Sunny Side Yard on Long Island for purposes of storage cleaning, etc., and this must be combined with the movement out of the station of the through equipment with electric locomotives to the same Yard for

the same purposes through a parallel tunnel. The division of the currents of movement, which is effected by a skilful separation of grades and a loop entrance into Sunny Side Yard, results in a quite complicated track plan, which is appended to this report (fig. 4). The development of proper facilities in connection with the electric transportation is very consistently worked out.

Question 1-*d*. — *Have you any stations with separate floors in which the tracks are, either all or in part, either on an upper floor or in a basement, the ground floor being used for different offices (enquiry offices, booking offices, luggage offices)?*

Quite a number of stations are found in which the tracks are, either all or in part, on an upper floor or in the basement, and where the ground floor is used for the different offices.

In the case of a mixed arrangement, that is to say, when some of the tracks only are at another level than the ground floor, which tracks are at that level and which tracks are on the ground floor?

Few cases of a mixed arrangement of tracks as described are found; in such instances, however, the ground floor is usually used for the main line or through tracks, and the suburban level is in the basement.

In the case of stations with separate floors, how are the different services distributed between the ground floor and the other floor?

Where stations have separate floors, the offices are usually distributed between the two floors according to space and utility. Effort is made to avoid duplication.

What circumstances : topographic location, difficulty of widening, etc.,—have led to the adoption of separate floors?

The adoption of separate floors has resulted in parge part from the requirement of cities that tracks be elevated or depressed to eliminate grade crossings and avoid smoke. Supplementary cases are : Topographic conditions, high value of real estate, enormously increased passenger business.

What advantages do you consider this arrangement to have to make up for the increased amount which as a rule such a station costs to build and run?

The rapid increase in wealth of the country has brought about a heightened demand for luxury and accomodation in all lines. The railroads, in building elevated stations, have been able to consult and gratify this growing taste by vastly

improved architecture and interior arrangements — as expressed in lighting, heating, ventilation, sanitary conditions, and many other forms of public comfort. In a number of instances, this development has taken the form of high public spirit.

Other phases are shown in the following typical replies of the railroads :

New York Central & Hudson River Railroad.

Yes. See plan of Grand Central Station, New York City (fig. 2).

At some stations the ground floor is used for the waiting room and offices, and the tracks are at a higher level and are reached from the waiting room by a transverse subway under the tracks. At other stations, tracks at lower level are reached by stairways.

Main tracks on te ground floor level.

By stairways and inclines.

Cost of land; elevation of subway lines; necessity for eliminating grade crossings; natural differences in grades in railways and highways

Convenience to the public; compactness; facility of operation.

Pennsylvania Railroad.

Broad Street Station, Philadelphia; Washington; Jersey City; Harrisburg; New York (under construction [fig. 3]).

Topographic and limited available space.

Additional floor space. At Harrisburg enabling the throwing of bridges for use of passengers and baggage across track.

Philadelphia & Reading Railway.

At Terminal Station, Philadelphia, tracks and waiting rooms are on the second floor. Ticket offices and baggage rooms are on the first floor.

Tracks are all on the same level.

Elevators are used from first to second floors.

At terminals in cities, it is frequently necessary to place tracks above street levels, baggage is handled from street level making it necessary to separate the floors, placing baggage room on street level and tracks above street level.

No advantages other than those stated.

Baltimore & Ohio Railroad.

The stations having separate floors are : Union Station, Washington, D. C.; Camden Station, Baltimore, Md.; Wheeling, W. Va.; Columbus O.; Youngstown, O.; and Wilmington, Del.

Camden Station, Baltimore, has the through tracks depressed and the suburban tracks on the ground floor.

At Union Station, Washington, all trains from northern roads come in on the ground floor and all trains from southern roads on the basement floor.

At these two stations, the ground floor is occupied by waiting rooms, ticket office, concourse, dining room and restaurant. At Camden Station, the baggage room is also on the ground floor, while at Washington it is on the basement floor.

At Wheeling, Youngstown and Wilmington, where the tracks have been elevated to eliminate grade crossings, the waiting rooms, ticket office, baggage room, restaurant, express office, etc., occupy the ground floor of the station. The elevated tracks are covered by train shed, to which the passengers are admitted only on arrival and departure of trains, there being an underground concourse which permits of access only to the platform adjoining the track on which the train is to depart. Or from incoming trains access can be had to the station only by elevators or stairways from the one platform, it being so arranged that passengers cannot cross other tracks.

At Columbus there is a Union Station, and the conditions are the reverse. The tracks are depressed and the station elevated to the level of the adjoining streets. In this instance, the ticket office, restaurant, and waiting rooms are on the first floor of the station, the ground floor being used for baggage and express rooms. An overhead structure spans all the tracks under the station, with gate entrances to the various platforms, so that the passengers have access to only the platform adjoining the track upon which the train arrives or departs.

The topographic conditions govern almost entirely the arrangement of our stations, as where tracks are depressed and the waiting rooms on an elevation with the streets, an arrangement such as at Columbus is thought a good one; whereas, if it is thought necessary in the elimination of grade crossings to elevate the tracks, an arrangement such as at Wheeling or Youngstown is thought to fully meet the local requirements.

The advantages to be gained in arrangements of this kind are, to reduce the danger to human lives by the elimination of grade crossings and arrangements at the station whereby passengers have access to their respective trains without crossing other tracks, the increased speed permitted on account of no grade crossings, time saved and delays avoided account of proper facilities for changing engines and adding to or taking away cars on through trains, saving in watchmen and maintenance of crossing gates at crossings, and the convenience afforded the travelling public.

Chicago, Burlington & Quincy Railroad.

A few stations have separate floors for passengers, but not for trains.
All tracks are on the same level.
To get below or above street level with railroad tracks.

Chicago, Rock Island & Pacific Railway.

At Chicago the trains run on the second floor, the first floor being used for ticket office, dining room, telephone and express room, the second floor being used for all trains. No tracks on any other floor.

St. Louis & San Francisco Railroad.

At St. Louis, all baggage is handled by elevators from the platform level to the basement in order to avoid trucking along passenger platforms, as all tracks stub at the station. The baggage check room, however, as well as main waiting room, all ticket offices, telegraph and telephone offices, parcel check rooms, bureau of information, etc., are located on the main floor on track level. There is a waiting room and a restaurant on second floor for convenience of through passengers waiting for connections, etc.

At Birmingham, Alabama, the waiting rooms, etc. and tracks are on the same level, but access from the station building to track platforms is obtained through subways which take the passengers direct to the trains desired without necessitating the crossing of any other tracks at grade.

At Kansas City the main floor is on the track level, and, as the tracks run through it, it is necessary to cross other tracks at grade to reach any track not adjacent to the building. There is another waiting room and a restaurant on the second floor. This station is to be replaced by a new Union Station in the future.

The topographic conditions, question of present or future grade separation, and in some cases the amount of and peculiar conditions regarding the amount and shape of available ground should be considered in considering the adoption of separate floors. As a matter of safety, passengers should not have to cross tracks at grade to reach their trains, and as a matter of convenience the trucking of baggage on passenger platforms should be avoided where practicable.

Union Pacific Railroad.

In regard to passenger tracks at different elevations, we have no cases which call for this, but if necessary to do it would consider it advisable to arrange the tracks for suburban travel on the most accessible level.

As to the double platforms for quick unloading of passengers, stations with separate floors, travelling inclines, or moving stairways, — we have no terminals which call for arrangements of this kind.

Question 1-*e*. — *Have you adopted the solution of "double platforms" applied more especially on the French Northern Railway at St. Omer and Valenciennes stations?* (*Revue générale des chemins de fer*, November, 1904, May and June 1907.)

The double platforms, found at St. Omer and Valenciennes Stations, are not used. Under American practice the increased capacity would be secured by increasing the number of parallel tracks and island platforms. It is hardly feasible to build American station platforms long enough to receive two trains 500 to 800 feet each, in length, along one continuous platform, and allow between them room for crossover switches of a length 160 to 175 feet from point of switch to point of switch. To permit this, it is assumed — as confirmed by scale — that the Valenciennes platforms are aver one-half mile long and the St. Omer platforms over 1,500 feet long. This arrangement, in certain instances, would require a longer walking distance than the American public would cheerfully endure, except in trolley stations provided for summer business. The actual use of the track arrangement would seem at times to require that a train should be held within the station on the middle track until a platform could be cleared. The American public would become very impatient at this delay, and would not remain in the cars unless they where locked. The advantage secured by the plan in avoiding the crossing of

tracks by passengers and baggage trucks is secured in modern stations by overhead bridges and subways connecting the island platforms with the station building. Again, the American practice of using train sheds from 400 to 700 feet long, covering all the passenger tracks, is against it; the cost of operating three interlocking towers (about $5,000 per annum) for a station for only 13 trains per day in each direction, as at St. Omer, would ordinarily be considered prohibitive. As a whole, the design does not seem to be adapted to American conditions.

QUESTION 1-e-I. — *Have you adopted or experimented with any new arrangements of passenger platforms, so as to expedite the handling of crowds?*

Few experiments are reported. The New York Terminal Station of the Pennsylvania Railroad has high platforms. These platforms are 46 inches above the top of the rail, or about on a level with the car floor. Their use will involve certain changes in the vestibules and platforms of all cars entering the station. The 42nd Street Station of the New York Central & Hudson River Railroad, in New York City, shows high platforms. The Illinois Central Railroad reports:

> We have not adopted any special type of platform, but use a high platform, the elevation being the same as the floor of the car, these platforms being for suburban service only within the limits of the Chicago terminal district.

In general, however, the low platforms are found in American stations.

Have you adopted any new types of passenger cars with special reference to quick unloading?

The Grand Trunk Railway reports:

> For suburban traffic have adopted coaches with spaces at each end where seats are arranged like benches along the sides of the cars, as in the New York Subway cars.

The Illinois Central Railroad operates several trains consisting of cars of which the entire framework is steel. These cars have fixed seats for 100 passengers, arranged in sections transversely of the cars, with two aisles, one on each side of the car extending the entire length of the car, and connecting at the vestibules with end doors. Opening directly from the aisles are 24 sliding side doors, 12 on each side. These doors are placed equal distance apart throughout the length of the car, a door being opposite each section of eight seats. When the side doors are used, the station platforms are about the same level as the floor of the car, and at stations where the platforms are low, the doors and spaces at the vestibule ends of the cars are used by passengers entering and leaving, just as in ordinary end door cars. The doors may be opened separately by the passengers on arrival at the sta-

tion, or may all be closed and locked simultaneously by the guard, who rides within the cars.

Certain other roads show cars where the design has been altered so as to provide wider end doors, and whose steps extend to the low platform level. These show, by experience, an improvement in unloading.

QUESTION 1 *f.* — *Please enclose in your answer plans of the passenger stations on your railway, of each of the types considered (station at one level, mixed station, station with separate floors), which seem to you to satisfy most completely the two desiderata mentioned above; namely to increase the working capacity and the safety of the shunting operations. It would be of interest to state how many reception tracks for passenger trains there are at the stations in question, and how many trains are received on the whole of these tracks during twenty-four hours.*

The table following gives such data as are available as to the number of reception tracks for passenger trains and the number of trains, handled on these tracks in twenty-four hours :

STATION.	Number of reception tracks in station.	Trains handled in 24 hours
South Station, Boston :		
Boston Terminal Company	28	817 received and despatched.
42nd Street Station, New York :		
New York Central & Hudson River Railroad.	Present : 26 New : Express level... 33 tracks. (Inc. 5 loop tracks). Suburban level... 14 tracks. (Inc. 4 loop tracks).	615 — — — ... ...
New York Terminal Station :		
Pennsylvania Railroad	21	Proposed : P. R. R. 400 L. I. R. R. 600 Total. . . 1,000 Received and despatched.
Jersey City Station :		
Pennsylvania Railroad	12	322 received and despatched.
Wilmington, Del. :		
Pennsylvania Railroad	2	226 Line station. (Passing.)
Wilmington, Del. :		
Baltimore & Ohio Railroad	2	68 — — —
Broad Street Station, Philadelphia :		
Pennsylvania Railroad	16	587 received and despatched.
Philadelphia Terminal :		
Philadelphia & Reading Railway	13	361 — — —
Union Station, Baltimore	4	302 Line station. (Passing.)

STATION.	Number of reception tracks in station.	Trains handled in 24 hours.
Camden Station, Baltimore :		
Baltimore & Ohio Railroad	5 (Street level). 2 (Tunnel level).	119 received and despatched.
Union Station, Washington	20 (Street level). 11 (Tunnel level).	222 — — —
Harrisburg Station :		
Pennsylvania Railroad	8	189 Line station. (Passing.)
Union Station, Pittsburgh	19	417 received and despatched.
Wheeling, W. Va. :		
Baltimore & Ohio Railroad	4	44 line station. (Passing.)
Youngstown, O. :		
Baltimore & Ohio Railroad	4	20 — — —
Columbus, O. :		
Baltimore & Ohio Railroad	8	284 Union Station. All roads entering and leaving.
La Salle Street Station, Chicago :		
Chicago, Rock Island & Pacific Railroad .	24	155 received and despatched.
Union Station, St. Louis :		
St. Louis Terminal Railroad Association .	32	315 — — —
Buenos Aires Station :		
Buenos Aires Great Southern Railway . .	6	68 — — —

Of the plans appended to the report by the reporter, the following have been reproduced for publication. Where distortion of the plans has occurred by reason of reduction to permit the photographic process, the words " no scale " are marked :

Boston Terminal Company.

Boston, Mass. South Terminal : Diagram of tracks and signals (fig. 1).

New York Central & Hudson River Railroad.

Grand Central Terminal, New York City : Track plan on suburban level (fig. 2).

Pennsylvania Railroad.

New York Terminal Station : *a*) Track plan (fig. 3). — *b*) Plan of Sunny Side Yard, Long Island (fig. 4).

Washington, D. C., Union Station.

Track plan showing coach yard and engine facilities (fig. 5).

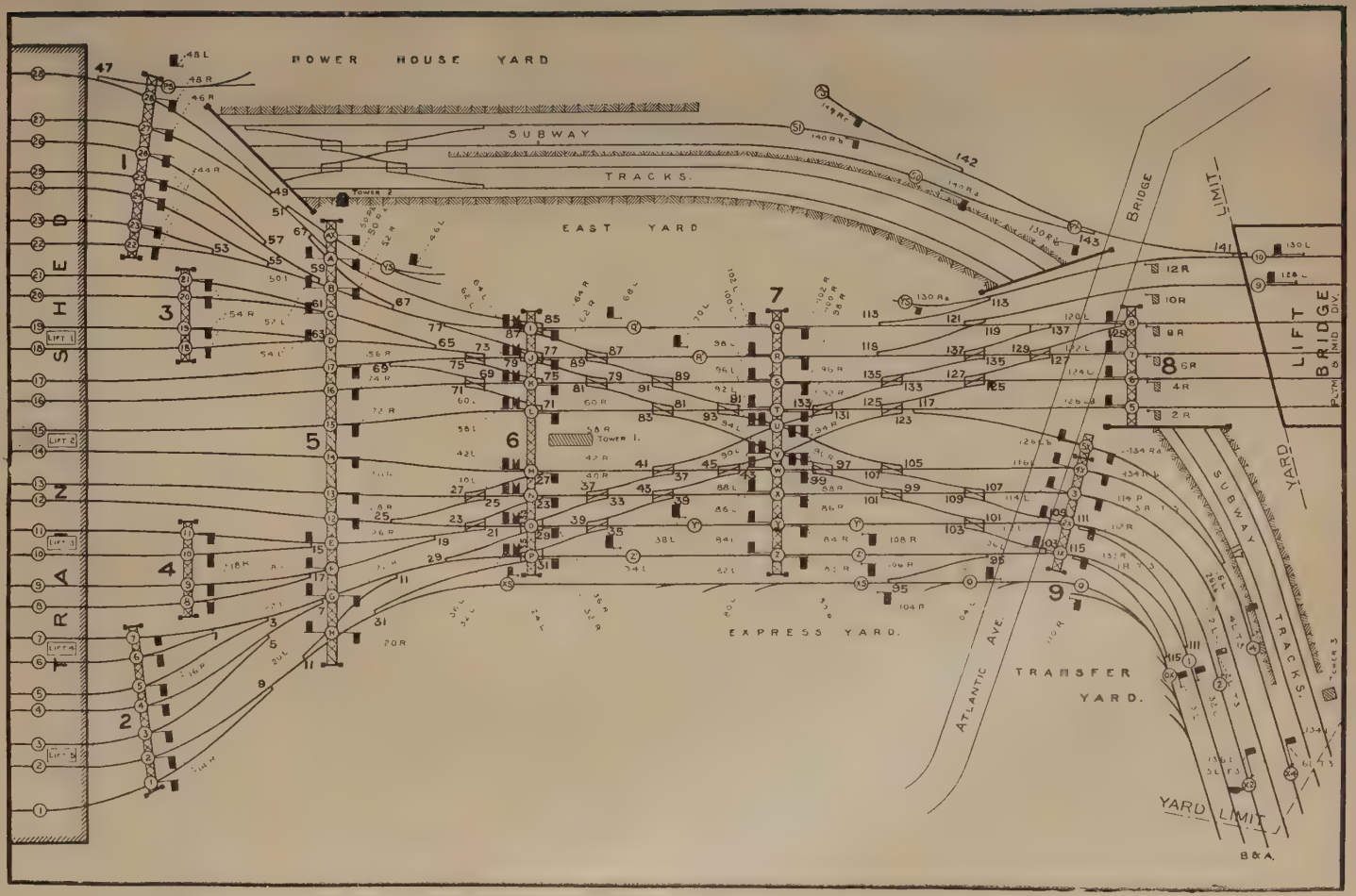


Fig. 1. — The Boston Terminal Company. — Boston, Mass. South Terminal. — Diagram of tracks and signals. — Not to scale.

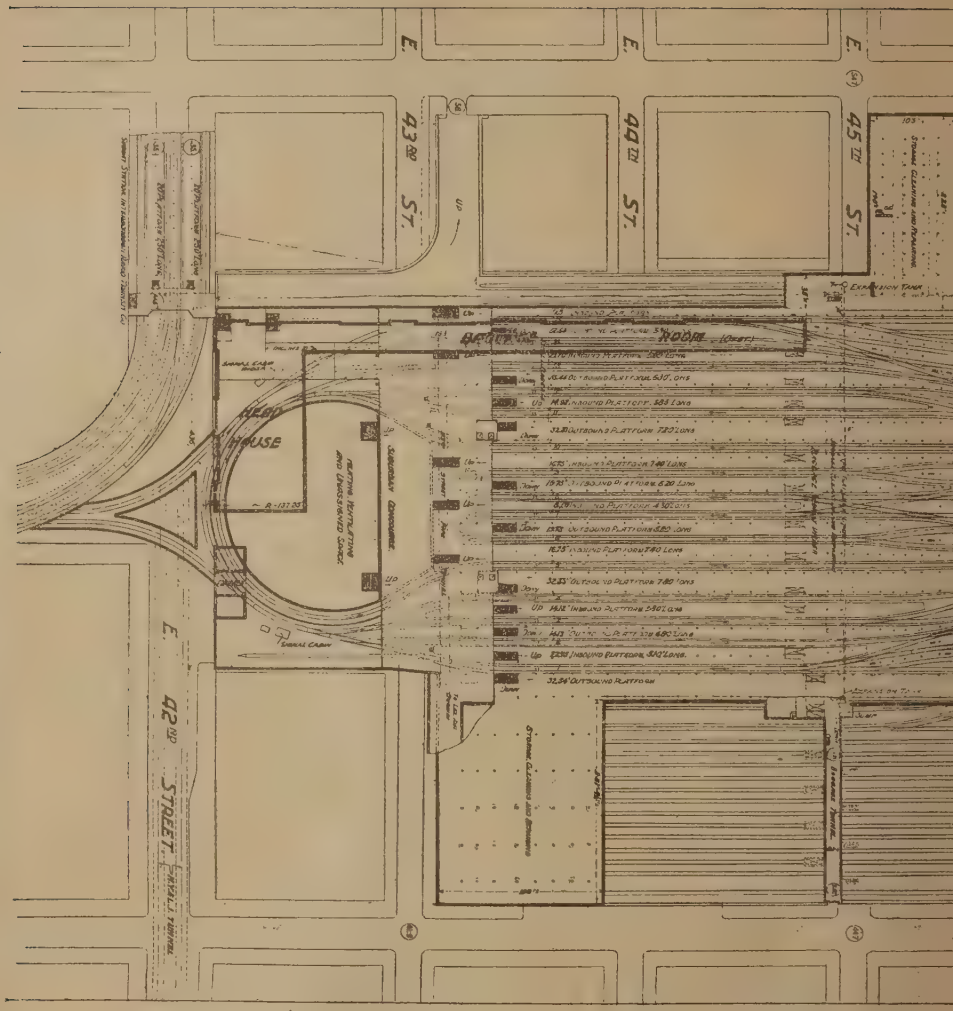
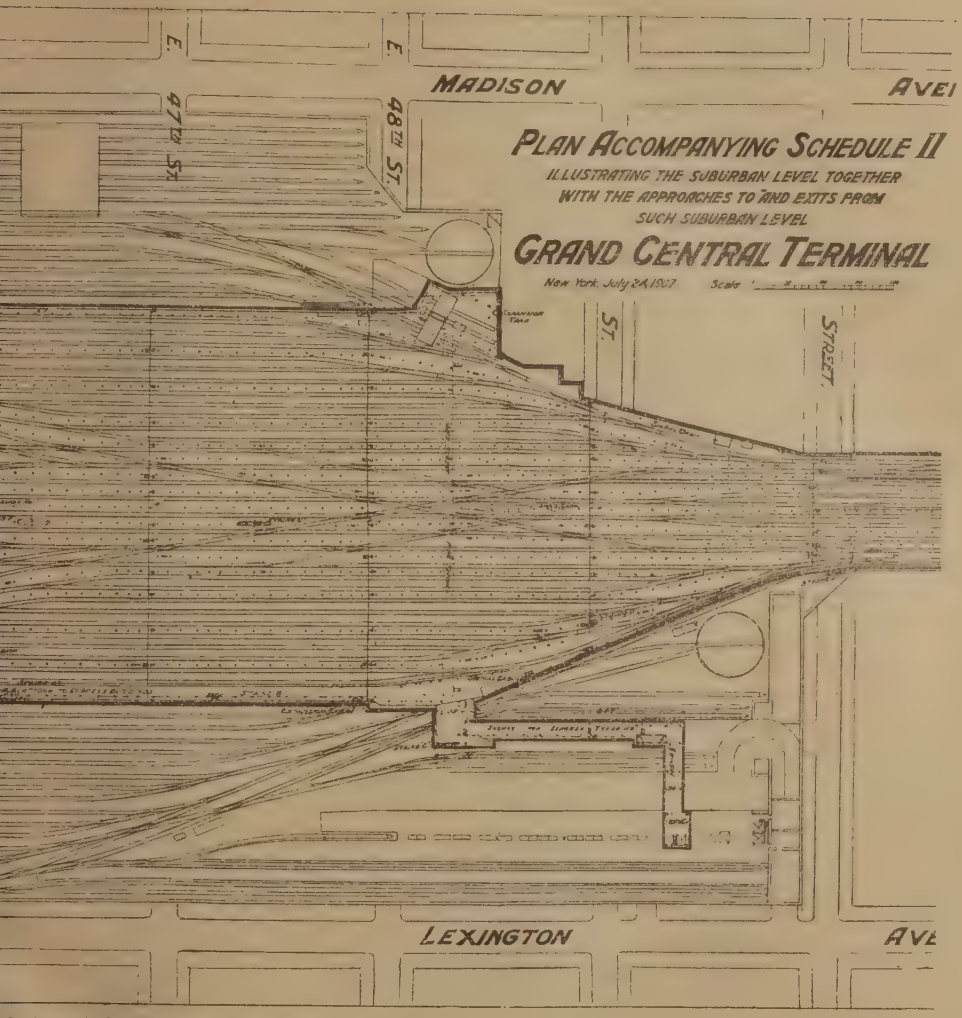


Fig. 2. — Grand Central Station, Ne

QUESTION 2. — *Please describe the mechanical appliances you have, either at the stations with separate floors, or at the stations at one level.*

a) For the conveyance of luggage (lifts, motor tricycles, travelling endless belts, electric automobiles, etc.).

As a rule, ordinary two-wheel and four-wheel trucks are used to convey baggage on a level. Wire rope haulage elevators (electric and hydraulic) and plunger eleva-



rk Central & Hudson River Railroad.

tors are used for moving baggage between levels. Electric baggage automobiles are in use at Jersey City, Broad Street Station, Philadelphia, Union Station, Pittsburgh — stations on the Pennsylvania Railroad — and Union Station, Washington. The Pennsylvania Railroad electric baggage trucks are described as follows :

Length over end standards, 12 feet; height of floor, 30 inches; width, 44 inches. Carrying capacity, 200 cubic feet (4,000 pounds), equivalent to 20 average size trunks.

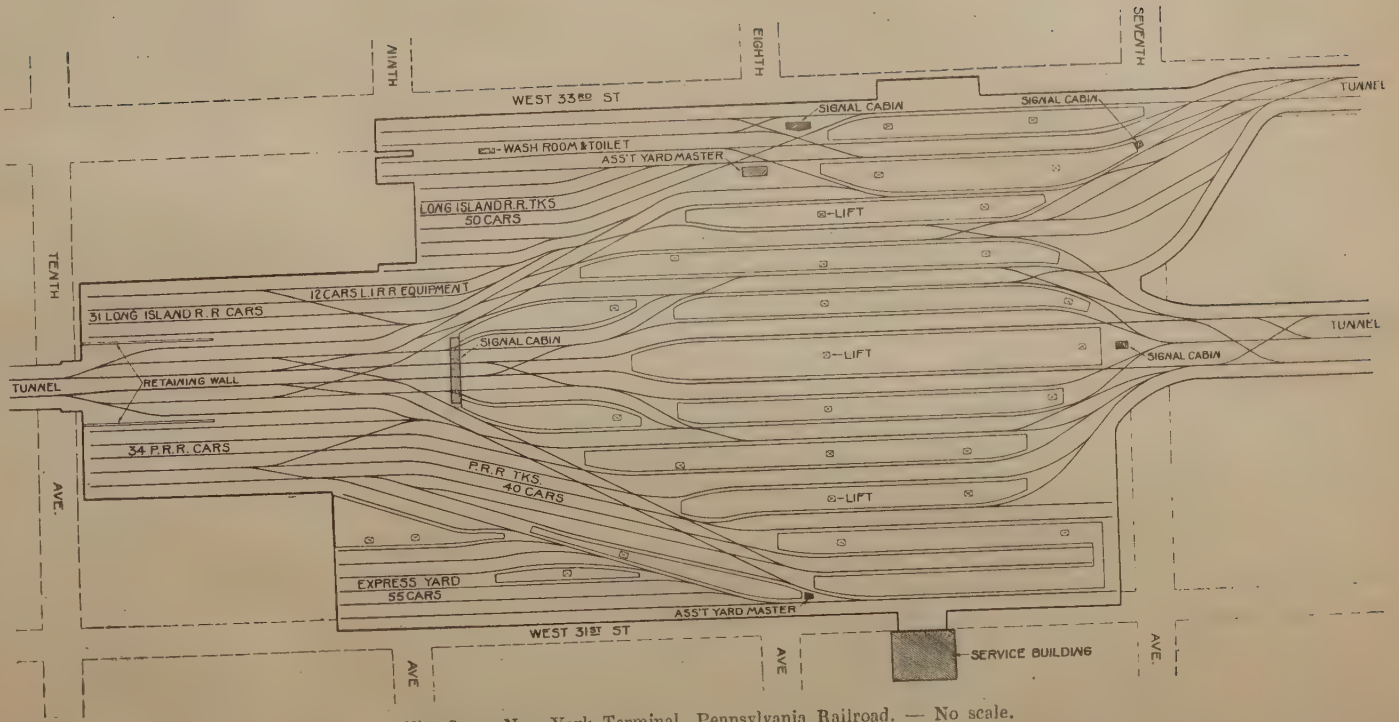


Fig. 3. — New York Terminal, Pennsylvania Railroad. — No scale.

Weight of truck, 2,590 pounds. The truck is provided with small platforms, one being mounted on each end; either of them may be folded up out of the way when not used. These platforms are for the use of the driver.

A steering lever and controlling handle socket are mounted on each end of the truck. The braking is done by brake pedal on the platform. The steering is done by all four wheels, which allows turning on a small radius. The controller provides for three speeds, the first to relieve the motor of shock, and the second and third being running speeds. The speed in the second position is from 4 to 5 miles per hour, and in the third position from 5 to 7 miles per hour.

The motor is of the four-pole series type, with fields arranged for series or series parallel control, and is flexibly mounted on the countershaft housing, and is powerful enough to handle the truck with a load of 4,000 pounds up a 6 per cent grade.

The battery is composed of 12 cells of 15 plates each, having a capacity of 196 ampere hours. The arrangement of the battery permits ready removal and replacement.

The wheels are of the artillery type; the rim is made in two sections, one of which comprises the rim proper, while the second section comprises the driving gear on the two wheels at the motor end of the truck. This section, however, is bored out to form a bearing for the internal expanding brake on the two wheels at the trailing end of the truck. The gear reduction between the motor and the driving wheels is 25 to 1. The driving wheels are mounted on steering knuckles similar to those used on the front axles of automobiles.

The construction is best shown by the figures 6 to 8.

Figure 6 : Shows the driver in position, with the steering handle turned to the right.

Figure 7 : Shows an assembled cam shaft and motor unit; the universal pinions are shown at each end of the housing, while a cyclometer is shown on the housing above the motor.

Figure 8 : Is a view of the chassis, showing the arrangement of the battery suspension, controller, and motor drive.

In the new Grand Central Station of the New York Central & Hudson River Railroad at 42nd Street, New York City, horizontal moving platforms will be used for the conveyance of baggage. These platforms will have a speed of about 200 feet per minute. They will be placed between the loop tracks on the express level, and will be three in number, serving five loop tracks; baggage will be unloaded directly from the cars of incoming trains to these platforms, which will move them to the distributing platform in the baggage room. It is not the intention to use these platforms for outgoing baggage; that will be handled by automobile trucks raised to the platform level by elevators located approximately ten car lengths from the bumping post.

Question 2-*b*. — *For the conveyance of passengers (lifts, travelling inclines, moving staircases, etc.)?*

The common practice is to use elevators of the plunger type or rope haulage. Moving staircases have been shown in recent designs, but so far have been little utilized.

Brief descriptions of the new Terminal Station of the Pennsylvania Railroad, in

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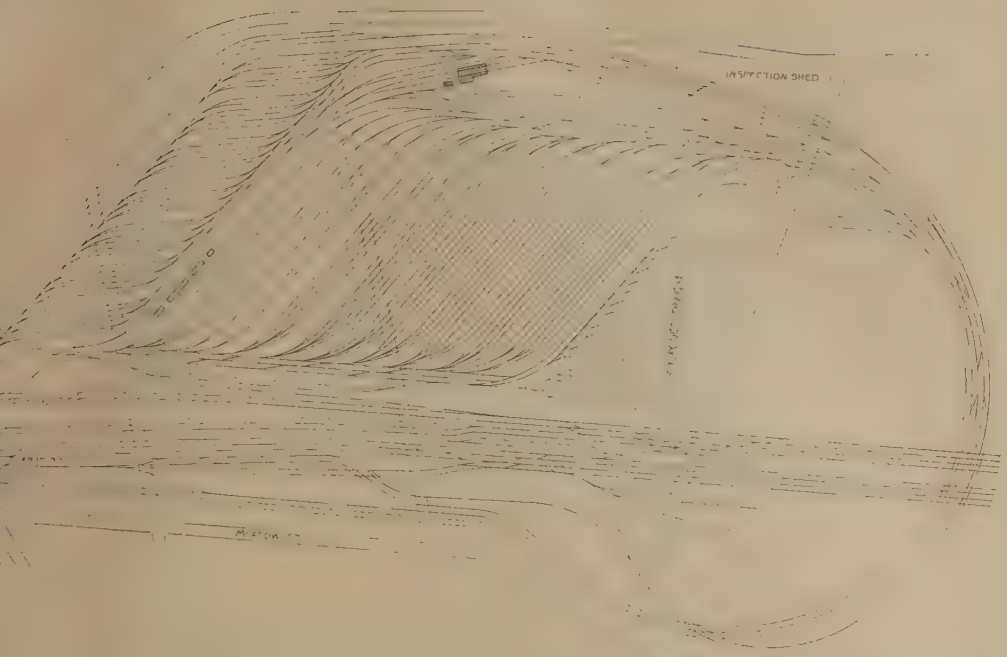
Fig. 4. — Sunny Sid

New York City, and the Union Station, Washington are given. The remodelling of the Grand Central Terminal of the New York Central & Hudson River Railroad, in New York City, on an elaborate scale is still in progress.

New York Terminal Station.

Pennsylvania Railroad.

This station is unique among the railway stations in the world, and its design will probably have much influence on the type of future stations in America. The introduction of



Railroad. — No scale.

electricity and the consequent elimination of the smoke nuisance has made it practicable to build a plant of monumental and durable character. The depression of the tracks to the level of 40 feet below the street surface, necessitated by the tunnel entrances, has presented a new problem in architectural design. The architects have endeavoured to give to the exterior of the building a familiar railway expression, and have been guided, as well, by the idea of expressing the magnitude and dignity of its position in a great city, not only as a distributing point for transportation, but also as a monumental gateway. This result is believed to be obtained by the simple, severe, and dignified character of the exterior, as particularly illustrated by the monumental colonnaded treatment of the 7th Avenue front.

Fig. 5. — Union Station, Washington D. C. — Coach yard and engine facilities. — No scale.

Key :

A . . . . . — Mail yard.
B . . . . . = Engine yard.
C . . . . . = Milk yard.
D . . . . . = Coach yard.
E . . . . . — Pullman car yard.
F . . . . . = Coach repair yard.
G . . . . . = Power house.
H . . . . . = Turntable.
J . . . . . = Engine storage 40 eng's.
1. . . . . = Inspection bld'g.
2. . . . . = Power house.
3. . . . . = Turntable.
4. . . . . = Express bld'g.
5. . . . . = Pullman car bld'g.
8. . . = Casting.
9. . . = Platform.
10. . . = Wheels.
11. . . = Master Carpenter's, smiths, etc.
12. . . = Store room.
15 . . . . . = Inspection pit.
16. . . . . = Ash pits.
17. . . . . — Coal wharf.
18. . . . . = Enginemens' bld'g.
19. . . . . = Oil.

Fig. 6. — Electric baggage truck. — Driver in position, with the steering handle turned to the right.

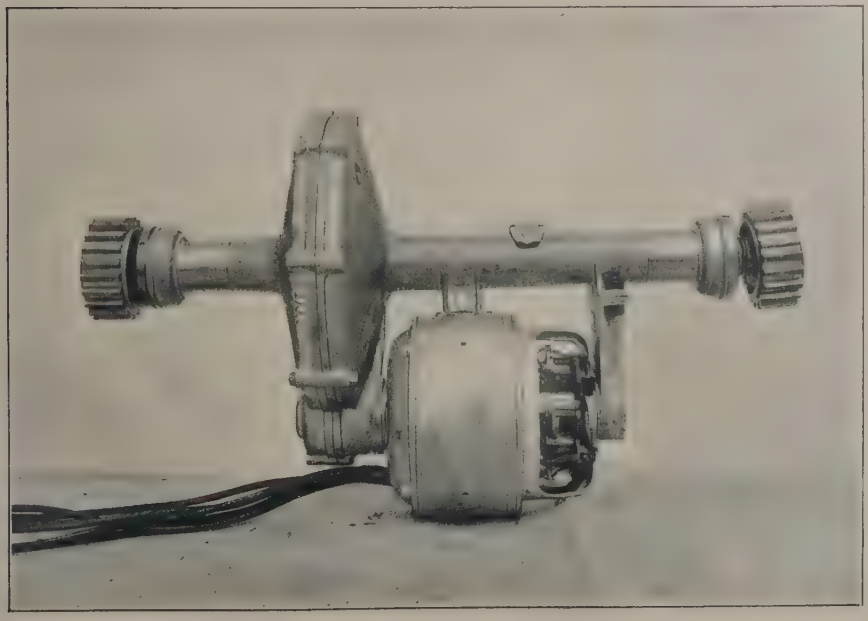


Fig. 7. — Electric baggage truck. — Assembled cam shaft and motor unit.

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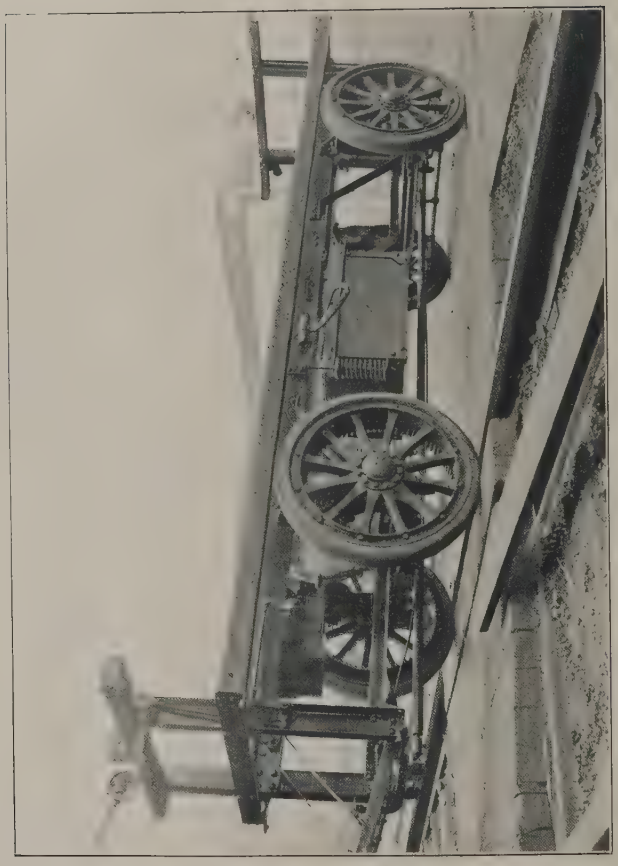

Fig. 8. — Electric baggage truck. — View of the chassis.

From the street level upward, the walls of the structure rise to a height of 60 feet, except in the center, where the roof of the general waiting room reaches a height of 150 feet, and the corner of 8th Avenue and 33rd Street, where there is an elevation of four stories for office purposes. The architectural exterior effect is that of a Doric colonnade, 55 feet high, surmounted by a low attic, raising the general elevation to 60 feet. The exterior construction is of pink Milford granite. The dimensions of the passenger station building are: 774 feet long; 455 feet wide. Dimensions main waiting room: 277 feet long; 105 feet wide; 150 feet high. The dimensions of concourse are: 340 feet long; 210 feet wide.

The character of the station has made it particularly difficult to arrange the various installations, such as ticket offices, baggage rooms, parcel rooms, etc., convenient for all of the general public, inasmuch as the station will be entered in many directions. The effort has been to arrange these installations so as to cause the passengers to cover the least possible distance under the various conditions. A passenger coming by carriage to leave New York, and entering the station by the 31st Street carriage drive, first has his baggage removed to the baggage room, where he is given an exchange coupon. He then leaves his cab and enters the general waiting room, directly adjacent to the ticket offices, where he can proceed to the baggage room checking counter on the central axis of the building, checking his baggage on his exchange coupon; thence he may, if he desires, go to the parcel room, and thence into the various sub-waiting rooms or directly to the concourse, without in any material way retracing his steps. The interior arrangement provides for the handling of baggage between the train platforms and the baggage room in automobile trucks; lifts are provided for all the platforms at both the eastern and western ends of the station, the platforms being connected from above by overhead passages at the waiting room level and by subways below the tracks, and, further, by a continuous driveway 30 feet wide the entire length of the station under 31st Street. As previously described in this report, three general classes of traffic will be handled in this station. A sub-division of the Long Island suburban traffic is made possible by arranging for shuttle trains at the north end of the station. Wide platforms, independent ticket offices, and special entrances and exits directly from and to the street and to adjacent subways in both 7th and 8th Avenues (when constructed) are provided. This feature of the station permits the rapid handling of large crowds on race days. By means of a skilful arrangement of street exits, entrances, interior stairways, landings, etc., a very thorough separation is made of incoming from outgoing passengers, the separation beginning at the passenger platforms and ending practically at the building line. This object has received much study and has been very successfully attained.

A very complete signalling and interlocking system for the terminal yard and tunnels has been adopted. The system is the electro-pneumatic of the Union Switch & Signal Company; four signal cabins will be employed. The double indication or over-lap system of blocking is employed through the tunnels and up to the yard switches. Track circuit route locking is employed for all switches, with automatic release of sections in the rear of train. Track circuit sections are used in place of mechanical detector bars at switches. Illuminated track models are provided in the towers, showing the occupancy of all track sections, these illuminated models being actuated by track circuits.

The station is for both through and stub end operation, but for the majority of movements it may be considered a stub end station. Through trains will be handled by electric locomotives; all Long Island trains by multiple unit motor car service. A great majority

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of the through main line trains, after discharging their passengers, will proceed through the East River tunnels to Sunny Side Yard, on Long Island, where they will be turned and cleaned; certain of the Pennsylvania locals and short distance expresses will be switched in the yards at the west end of the station and returned without going to the main cleaning yard above referred to. No loop has been employed for turning trains, except as a loop forms the entrance to Sunny Side yards. Shortly after the opening of the station, all cars entering will be of steel.

Area of Terminal Yard (10th Avenue to normal tunnel section east of 7th Avenue)	28 acres.
Length of trackage	16 miles.
Number of standing tracks at station	21.
Length of platforms adjacent to passenger trains	21,500 feet.
Number of passenger platforms	11.
Number of baggage and express lifts	25.
Weight of station building, steel	25,000 tons.
Total excavation required	3,000,000 yards.
Storage capacity of station yard	586 cars.
Maximum capacity of tunnels to and from station in trains per hour	144.

2 single tracks under North River.
4 single tracks under East River.

Union Station, Washington.

The chief architectural line of the building is the Roman Arch, and the entire effect is appropriate to the Capital of the Nation. It is constructed entirely of white granite; 621 feet long, and from 65 feet to 120 feet in height. In the center is a general waiting room 150 feet wide and 220 feet long, modelled after the Baths of Diocletian. The concourse, 150 feet by 750 feet, is divided its entire length by the usual fence, placed 85 feet from the station building walls. A portico runs across the front and sides, affording protection from the weather. Facing the station is a plaza, 500 feet wide by 100 feet long, from which radiate nine avenues and streets.

The ticket offices and baggage departments are in close proximity to the waiting room and concourse. One end of the building is devoted to a special entrance and waiting rooms for the President of the United States and distinguished guests of the Nation. The upper stories of the building are utilized for executive offices.

20 stub tracks are on the concourse level and 8 through tracks are on the basement level leading from the tunnel, with 3 storage tracks along the eastern side for baggage and mail cars. The tracks on the upper level are served by 13 platforms provided with umbrella sheds; the lower tracks are served by 5 platforms. Of the 13 platforms on the upper level, 3 are used for handling baggage, mail, and express matter, exclusively, each platform serving 2 tracks. At the end of these, next to the concourse, are elevators leading to the baggage room in the basement. The passenger platforms are 915 feet long and 20 ft. 7 1/2 in. wide. Nearly the entire basement is used for the handling of baggage and mail matter. The level of this floor is 16 feet below the concourse, and is reached on the

east and west sides of the building by a driveway descent from the plaza level on a 6 per cent grade. Baggage from trains standing on the high level tracks is delivered to the sorting room, either by elevators at the south end, which open directly into the large space under the concourse, or by the elevators at the north end, which open into a runway parallel to 8th Street. North of the station tracks, on the east side, lie the express companies' building, 60 feet by 420 feet. A power plant, 75 feet by 255 feet, and car inspectors' storehouse, 50 feet by 150 feet, are situated almost directly across the yard from the express building. A power tunnel connecting the power house and the station is located next to the west retaining wall. A turn-table, just beyond the power plant, is used in emergencies. All the roundhouses and car storage yards are outside the city limits.

The following railroads enter this station :

Pennsylvania Railroad;
Baltimore & Ohio Railroad;
Washington Southern Railway, and the Richmond, Fredericksburg & Potomac Railroad;
Southern Railway;
Atlantic Coast Line;
Chesapeake & Ohio Railroad;
Seaboard Air Line.

B. — CONCERNING LARGE FREIGHT YARDS.

QUESTION 1. — "*Are the tracks at some of your sorting and shunting yards arranged so as to insure continuity of movement, in one given direction and consequently without any reversal of the cars to be handled, from the time an arriving train is received until a train is made up and ready to depart?*"

Almost all recently built yards groups secure continuity of movement through the various component yards. The older yards were, in many cases, merely collections of sidings, added to from time to time as the business increased. They necessitated tail switching without securing continuity of movement. The usual arrangement consists of a receiving yard, with long tracks to receive trains from the road; thence the cars pass into a classification yard; thence into a departure yard; and thence out on the road.

QUESTION 1-*a*. — "*Are these tracks on a continuous incline, so that the cars can be classified by gravity without requiring a locomotive, or do they consist of successive groups of level tracks commanded by humps on to which the trains are put by locomotives? Are there successive gridirons or specially arranged yards which allow a train to be classified according to destination and on which the making up of local freight trains, preference trains and others*

of limited tonnage can be completed? In case of full tonnage trains, do you use a distinct departure yard in advance of the classification yard? What track arrangements do you use for handling cripple cars and cars to be cut out for any reason?"

The present practice shows an extensive use of the hump between the receiving and classification yards. Locomotives push the trains to be classified over the hump, and they run by gravity to their appropriate tracks, switches at the entrance to the classification yard being worked in the larger yards by air or electricity, and in the smaller yards by hand levers. In a recent compilation, out of a total of 510 classification yards shown, 82 are hump yards. In this compilation, the Baltimore & Ohio Railroad shows 8 hump yards out of a total of 18; the New York Central & Hudson River Railroad shows 3 hump yards out of a total of 9; the Pennsylvania Lines East & West of Pittsburgh show 31 hump yards out of a total of 209; the Chicago, Rock Island & Pacific Railway, the Michigan Central Railroad, the Missouri, Kansas & Texas Railway, and the Wabash Railroad are shown as contemplating hump yards. Intermediate in age between the old collection of sidings and the hump type is the poling yard. Few yards of this type are now being built.

The Northern Pacific Railway replies thus :

This Company has no modern yards designed to handle a complicated traffic. Its new yards are intermediate terminal points, and aside from having separate east and westbound yards on double track divisions, has no special features in this department.

The St. Louis & San Francisco Railroad reports :

We have no switching yards which are arranged to insure continuity of movement in one direction from the time an arriving train is received until the train is made up and ready to depart; neither have we any hump yards. Classifying of cars according to destination is ordinarily done on one or more of the tracks in the same yard which the train enters on arrival. Outgoing trains are ordinarily made up on one or more tracks of the same yard. In some cases, we have one or two tracks which are used practically as a departure yard.

The Buenos Aires Great Southern Railway replies :

Of the class mentioned none exist on this system.

The Philadelphia & Reading Railway is the only road which reports a yard on a continuous incline. That road says :

In the yard at St. Clair a continuous incline is used, and cars are classified by gravity and without the use of a locomotive. In the yard at Rutherford a hump is used between the receiving and classification yards over which it is necessary to push cars to be classified by a locomotive.

Gridiron yards are not used. Usually the work of detailed classification is done

by means of tail switching at the end of the classification yard. This is recognized as very disadvantageous, since it interferes with the movement out of the classification yard. The De Witt Yard, of the New York Central & Hudson River Railroad, shows a westbound reclassification yard alongside and parallel to the westbound advance yard. Eastbound fast freight and way freight sorting yards lie in part between the eastbound classification and eastbound advance yards. Gardenville Yard, of the New York Central & Hudson River Railroad, shows the same general characteristics. The new Northumberland Yard, of the Pennsylvania Railroad, shows a somewhat similar arrangement. In other words, while the old practice is to accomplish the refinements of classification by tail switching, the new yard designs show specially designed yards for this purpose.

Use of distinct departure yard.

The general practice in the case of almost all the large modern yards is to show a distinct departure yard in advance of the classification yard.

Crippled car arrangements.

The usual arrangement for handling crippled cars is to assign a track in the classification yard into which they drop from the hump. Two roads report a cripple yard or cripple spurs having a direct connection from the hump. This arrangement is usually impracticable, since the space between the receiving yard and classification yard is too small to permit of a repair yard. The new Northumberland Yard, of the Pennsylvania Railroad, shows special treatment of this feature. Enola, Altoona, Pitcairn, Conway, Scully & Chicago Yards, of the Pennsylvania System, show varying methods of handling the cripple car problem. Cars are inspected in both the receiving and classification yards. In many instances, classification and departure yards are fitted with air plants to test air brakes, charge the trains, etc.

QUESTION 1-*a*. — *Do you use separate yards in classifying local freight, preference freight and through regular freight? That is, do you feed all the above classes of cars over one hump into one classification yard, or do you separate the above classes at the entrance to your yard and handle the three classes in separate yards and over separate humps?*

The general practice in yards of recent design is to feed all the various classes of loaded cars into one receiving yard and push them over the same hump into one classification yard. As a rule, the various classes of freight are not separated at the entrance to the yard group.

The following replies are characteristic :

Chicago, Burlington & Quincy Railroad.

All cars in one direction go over the same hump.

*

Fig. 9. — De Witt Yard, New

A. . = Storage yard 1,084 cars,	I. . . = Coal storage.	3. . . . . = Lumber
B. . = W. B. local reclassification 736 cars.	J. . . = Caboose.	4. . . . . = Coal stoc
C. . = W. B. advance yard 947 cars.	K. . . = W. B. receiving yard 1,058 cars.	5. . . . . = Office an
D. . = Repair yard 144 cars.	L. . . = E. B. advance yard 1,449 cars.	6. . . . . = Engine h
E. . = Receiving yard 789 cars E. B.	M . . = Repair yard.	7. . . . . = Shop.
F. . = W. B. classification 1,713 cars.	N. . . = 59 coal cars.	8. . . . . = Oil hous
G. . = E. B. classification 1,454 cars.	1. . . = Watchman's house.	9. . . . . = Power h
H. . = Fast freight 275 cars.	2. . . = Paint house.	10. . . . . = Water t

Delaware & Hudson Company.

Feed all over one hump into one classification yard.

New York Central & Hudson River Railroad.

Separate pockets of the classifying yard are used, or a small additional reclassifying yard.

Pennsylvania Railroad.

All trains except preference trains are fed over humps in the order of arrival. Preference trains handled on flat track. (At Pitcairn Yard the preference trains are fed over the humps.)

Pennsylvania Railroad Lines West.

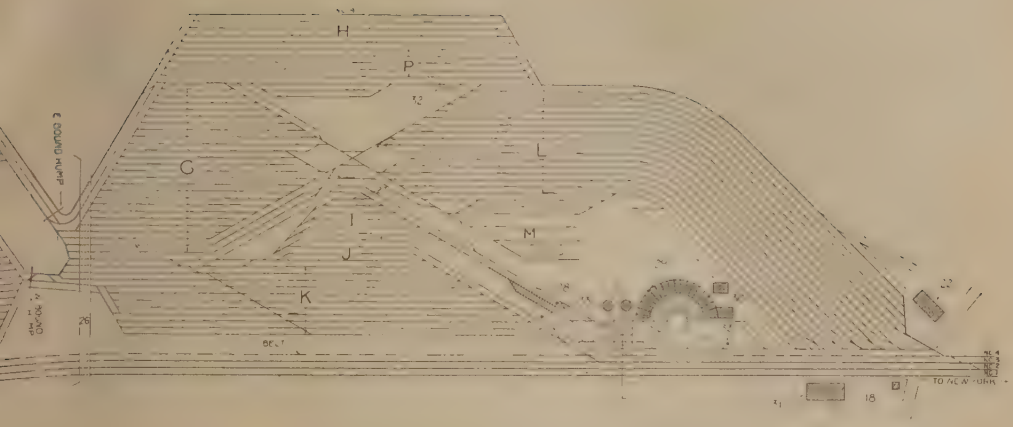
Generally they all over go one hump into one classification yard. In very large yards sometimes more than one hump is used, in which case some such division of work as suggested in the question may be adopted.

Grand Trunk Railway.

No.

Baltimore & Ohio Railroad.

Separate yards are not provided for classifying local freight, preference freight, and through freight; but all classes of cars are fed over one hump into one classification yard.



on River Railroad. — No scale.

. . . = Coaling station.	19. . . . . = Inspector.	27. . . . . = Empty coal car tracks.
. . . = Ash pit.	20. . . . . = Yard master's office.	28. . . . . = Trestle.
. . . = Sand drying plant.	21. . . . . = Repairs.	29. . . . . = Engine house 30 stalls.
. . . = Tools.	22. . . . . = Freight house.	30. . . . . = Office.
. . = Section house.	23. . . . . = Car repairs.	31. . . . . = Passenger station.
. . . = Toilet.	24. . . . . = Yard office.	P. . . . . = Way freight 416 cars.
. = Passenger station.	25. . . . . = Pump house.	32. . . . . = Scales.
. . . = Tower.	26. . . . . = Bridge.	33. . . . . = Water crane.

Chicago, Rock Island & Pacific Railway.

The Rock Island have never built any hump yards, but our preference would be not to use separate humps for classifying local freight and through freight, but only use one hump for all kinds, and if the business grows so as to require more than one hump, build another hump.

Northern Pacific Railway.

No.

Questions 1-*b* and 1-*c*. — *What system is adopted for stopping and again starting the cars in the cases mentioned above (hand brakes, sprags, skids, etc.)?*

Are all the cars which are classified at yards with continuous inclines fitted with hand brakes? How is the work carried out when this is not the case?

What arrangements are adopted for stopping run-aways (chain-drags, safety sidings, sand tracks, etc.)?

Hand brakes, which are provided on all cars, are depended upon to stop the cars. On certain roads the speed is limited by rule to 2 miles per hour. In the case of hump yards, men ride the cars down the humps into the classification yards and

apply the brakes as required. Effort is made in designing the grades of the hump and classification yards to so ligten the grades that the cars will stop of themselves near the end of the classification yard. The cars are started again by locomotives.

The Chicago, Burlington & Quincy Railroad replies :

All cars with bad brakes are coupled with cars with good brakes when practicable. At times cars with bad brakes are handled with a switch engine used to bring the car riders back from the foot of the incline.

Erie Railroad.

In the case of a defective brake the car is not cut off, but is placed with a locomotive.

Pennsylvania Railroad Lines West.

It is the duty of the inspectors to see that all brakes are in good order before the cars are sent over the hump.

Baltimore & Ohio Railroad.

In case of failure of hand brakes, the grade at the other end of the yard is such that the cars will stop before reaching the ladder track ; or if the track is partly filled with cars the contact will be insufficient to do anz appreciable damage.

In a few yards derailing switches are found. Skids, chain-drags, rail shoes, and sand tracks are used in exceptional cases.

Question 2. — *Have you adopted any arrangement of tracks making it possible to eliminate any interruption of the classification and making up operations owing to the arrival and departure of trains ? What is your arrangement in regard to position of roundhouse and car repair shop to allow 1° and 2° ?*

All recent designs are intended to eliminate interruption of classification due to arrival and departure of trains or to the various currents of movement, such as road engines leaving and moving toward trains, shifting engines, movement of crippled cars, distinct classification of local freight trains, etc. The results obtained are satisfactory, and the more successful yards suffer little interruption under normal conditions.

It is generally recognized that the position of the roundhouse should be near the center of the yard group, that is, if the east and westbound yard systems lie directly opposite each other, then the roundhouse should be in the middle space between the two humps leading into the cassification yards. Local circumstances, topography, preponderance in direction of traffic, necessary distribution of yard buildings, etc. affect this situation. Few yards actually show the roundhouse in the

center. In certain yards, it is necessary to provide a transfer house for package freight, ice houses, storage spaces, etc. All of these considerations enter to affect the position of the roundhouse and car repair shop. In general, endeavour is made to so place the roundhouse as to involve about equal travel for the road engines of the entering roads in reaching it and leaving it, while causing the least interference with other movements. No generalization can be made of the various replies as to the actual position of car repairs yards. The individual conditions are too unlike. On this question the Delaware & Hudson Company says :

Leads to roundhouse and repair tracks separate and distinct from the yards.

The Erie Railroad says :

Generally the roundhouse and car repair shop to allow 1° and 2° are located midway between the east and westbound freight yards.

The Pennsylvania Railroad Lines West say :

The roundhouse should be located near the center of the cluster, or general yard.

The Pennsylvania Railroad says :

Tracks are so arranged that there is no interference due to arrival and departure of trains. Roundhouse and car repair shops should be located between the east and west or north and south yards.

The Chicago, Rock Island & Pacific Railway says :

We aim to arrange the tracks so that there is no interruption to the switching arrangements during the arrival and departure of trains. Sometimes we have been obliged to depart from this but have always provided a place for switching engines with their trains to stand while trains are arriving or departing.

Question 3. — *What importance do you attach to the realization of the different preceding conditions (continuity and uniform direction of movement, elimination of all interruption to shifting operations) ?*

Does the advantage obtained by this realization justify, to the same extent in each case, the large size to be given to the yards and the resulting expense ?

The concensus of opinions of all roads is that uninterrupted classification is of the greatest importance, and that expenditures to obtain this have been justified by results.

It is believed that by the aid of a hump cars can be handled more quickly and at lesst cost than with any other form of yard. The success of the operation may be judged from the following results shown in a representative yard, where mineral

*

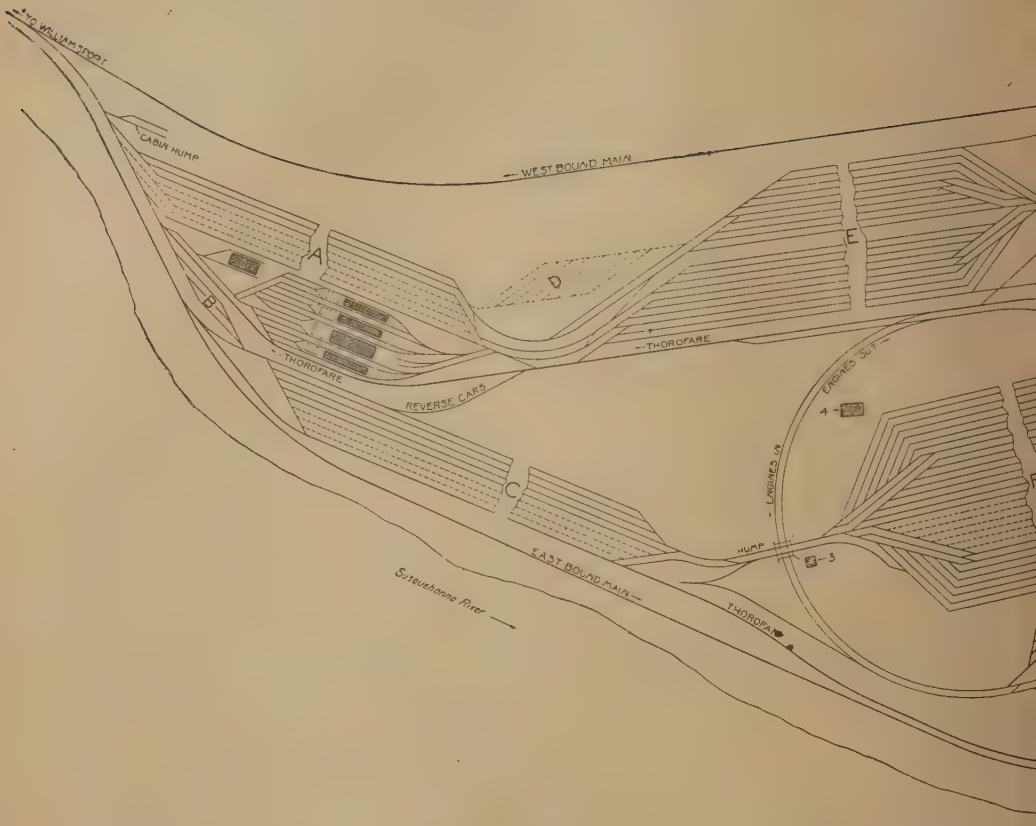
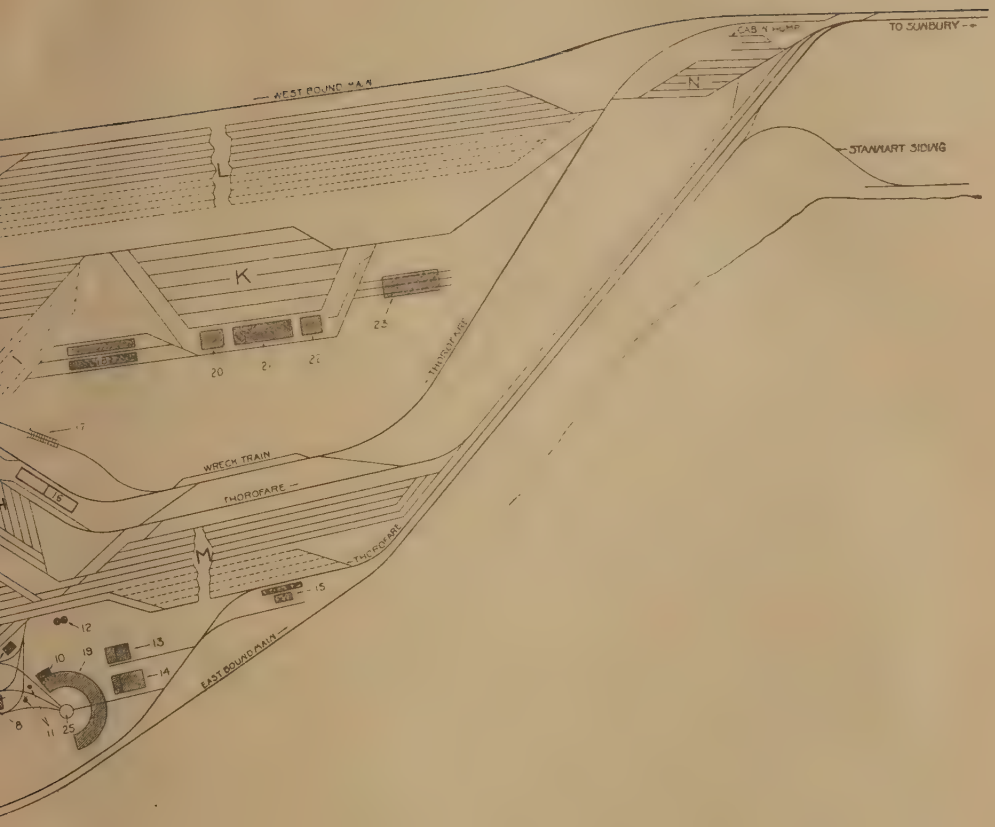


Fig. 10. — Northumberland

A. . = West bound departure tracks total 733 cars.
B. . = Cabin yard.
C. . = East bound receiving tracks total 750 cars
D. . = Station order sifter.
E. . = West bound classification tracks total 859 cars.
F. . = East bound classification tracks total 1,170 cars.
G. . = Engine storage.
H . = Station order sifter.
I . . = Cripple cars.
J . . = Cripple cars.
K. . = Car repair.
L . . = West bound receiving trac 1,163 cars.
M. . = East bound departure trac 805 cars.
N . . = Cabin yard.
O . . = Coal storage.
1 . . = Material wharf.
2 . = Transfer station.



Railroad. — No scale.

. . . = Tower.	11. . . . = Stand pipes.	19. . . . . = Round house 36 stalls.
. . . = Yard master's office.	12. . . . = Water tubs.	20. . . . . = Planing mill.
. . . = Insp. house.	13. . . . = Power house.	21. . . . . = Store house & office.
. . . = Insp. pits.	14. . . . = Machine shop & store house.	22. . . . . = Smithy.
. . . = Ash pits.	15. . . . = Icing station.	23. . . . . = Shop for wreck gang.
. . . = Coal wharf.	16. . . . = Stock pen.	24. . . . . = Scales.
. . . = Oil house.	17. . . . = Transfer trestle.	25. . . . . = Turntable 100 ft. dia.
. . . = Office.	18. . . . = Transfer station.	*Note*: Future extension show thus -------

traffic is handled in large volume, confining the figures given to the eastbound side, except where specified :

Maximum number of trains entering the yard in one hour is 7, with an average number of 50 cars per train.

Average number of trains entering the receiving yard in 24 hours is 33.

Average train pushed over the hump is 68 cars, 3,800 tons.

One pusher engine is used in handling some of the trains, but with the majority of trains it is necessary to assist the pusher engine with a pole which works alongside the train to be shifted. Two engines are used in extra cold weather only.

Cars to be weighed are uncoupled. The scales are not located on the hump. The amount of weighing is small, and does not interfere to any great extent with the work.

The classifying capacity of the hump as determined by continuous operation is as follows :

	Eastbound.	Westbound.
One hour.	81 cuts.	108 cuts.
Five hours	291 —	389 —
Ten hours	580 — 1,318 cars.	688 — 1,396 cars.
One day (24 hours)	900 — 2,151 —	1,205 — 2,488 —

The hump is in actual operation 15 $^1/_2$ hours out of each 24.

There are 15 car riders employed.

The switches are operated by air. One man is assigned to this work at each hump.

The cost per car for yard handling (from the time the road engine is cut off on the receiving track until the road engine is coupled to the train on departure track) is $0·10.

The cost per car, averaged from the operations of 22 representative yards, is $0·13. The figures vary from $0·05 per car for the Winnipeg Yard, of the Canadian Pacific Railway, to $0·32 per car for the Potomac Yard, of the Washington Southern Railway.

Three railroads state that the advantage obtained from the use of the large yards justifies the expense in about the same degree in all cases. The general feeling expressed by the roads, however, is that the advantages are not alike in all cases; that the matter depends upon the volume of traffic and on local conditions. The St. Louis & San Francisco Railroad says :

We feel that the expense incurred for the elimination of all interruption is ordinary fully warranted.

Question 4. — *Please enclose in your answer plans of the yard or yards best satisfying the two conditions 1° and 2° above. Please also state what area is occupied by these yards and what the total length of track is, and how many cars are handled every twenty-four hours ; each car arriving at the yard to be counted as one unit only.*

A list of plans of yards appended to this report follows, together with available

data as to area occupied, total lenght of track (thesefeatures in part scaled), and number of cars handled in 24 hours.

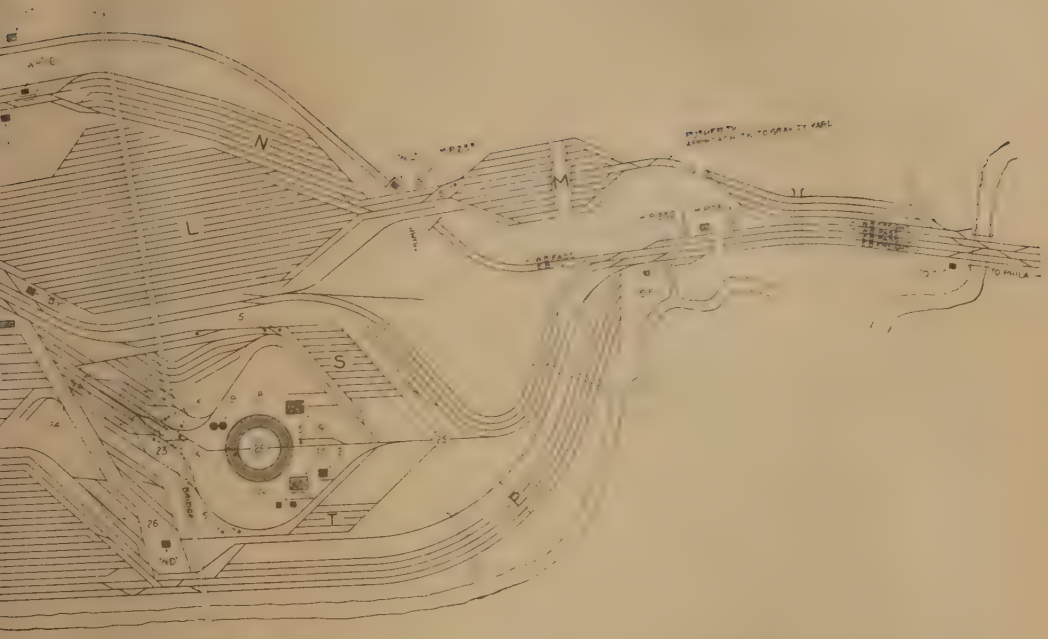
Some of these plans (figures 9 to 15), have been reproduced for publication. Where distortion of the plans has been necessitaded to allow reduction to a size to permit of photographic reproduction, the words "no scale" have been marked.

NAME OF YARD.	Total lengh of track.	Area.	Cars handled in 24 hours.
Boston & Albany Railroad.			
I. W. Springfield Yard	51 miles.	130 acres.	1,155
New York Central & Hudson River Railroad.			
II. De Witt Yard (fig. 9)	122 miles.	250 acres.	4,400
III. Gardenville Yard	300 —	700 —	10,000
Philadelphia & Reading Railway.			
IV. St. Clair Yard	19 miles.	65 acres.	...
Pennsylvania Railroad.			
V. Northumberland Yard (fig. 10)	69 miles.	342 acres.	...
VI. Enola Yard	72 —	267 —	...
VII. Altoona Yard (fig. 11)	No. scale.	..	...
Pennsylvania Lines West of Pittsburgh.			
VIII. Conway Yard (fig. 12)	88 miles.	124 acres.	...
IX. Scully Yard	25 —	100 —	...
X. 55th St. Chicago Yard	28 —	39·2 —	...
Baltimore & Ohio Railroad.			
XI. Brunswick Yard	36 miles.	114 acres.	...
XII. New Castle Yard (fig. 13)	27 —	99 —	...
Illinois Central Railroad.			
XIII. Nonconnah Yard (fig. 14)	26·32 miles.	160 acres.	788
Chicago, Burlington & Quincy Railroad.			
XIV. Galesburg, Ill. Yard (fig. 15)	57 miles.	148 acres.	...
XV. Lincoln & New Yards, Neb.:			
a) Track plan	26 —	(Proposed track.)	...
b) Detail of tracks at hump	21 —	180 acres. (Present track.)	...
Union Pacific Railroad.			
XVI. Council Bluffs, Ia. Yard	89 miles.	123 acres.	...

*

Fig. 11. — Altoona Y

A . . = 17 th st. yard cap. 159 cars.	J . . = Repair tks. west bound cars.	T . . . .
B . . = Preference freight and advance s. cap. 558 cars.	K . . = West bound loaded class. yard cap. 630 cars.	1 . . . .
C . . = East bound receiving yard cap. 1,563 cars.	L . . = West bound empty class. yard cap. 1,528 cars.	2 . . . .
D . . = West bound advance tks. cap. 633 cars.	M . . = West bound empty receiving yard cap. 998 cars.	3 . . . .
E . . = West bound repair tks. cap. 534 cars.	N . . = West bound loaded receiving yard cap. 338 cars.	4 . . . .
F . . = East bound coal class. yard cap. 1,031 cars.	P . . = Advance tks. east bound cap. 464 cars.	5 . . . .
G . . = East bound class. yard cap. 1,422 cars.	R . . = Miscellaneous tks.	6 . . . .
H . . = Repair tks. east bound cars.	S . . = Engine storage Pittsburg div.	7 . . . .



Railroad. — No scale.

Middle div.	8. . . . . = Juniata scales.	16. = Metal yard scales.	22 . . . = Oil house.
	9. . . . . = Water tub.	17. = East Altoona sta.	23 . . = Coal wharf.
	10. . . . . = Scales.	18. = East Altoona round house 52 stalls.	24 . . . = Insp. pit.
	11. . . . . = Ash pit.		25 . . = Turntable.
	12. . . . . = Cattle pen.	19. = Machine shop.	26 . . . = Transfer trestle.
	13. . . . . = Ice house.	20. = Store house and office.	27 . . = Water plugs.
	14. . . . . = Icing platform.	21. = Power house.	28 . . . . = Repair shed.
n.	15. . . . . = Coal yard office.		

A synopsis of a study for the New York Central & Hudson River Railroad Yard at Gardenville, New York, for the Buffalo territory, is given. It shows a most consistent working out of the various features and, in general, very elaborate arrangements.

The westbound yards are shown in the following order:

Receiving yard of 20 tracks of 100 cars each;

Three car repair yards which can be reached from either the receiving yard or classification yard;

Hump leads from receiving yard into westbound classification yard, which is divided as follows:

Interchange with minor connections;
Buffalo deliveries and transfers;
Interchange with principal connections;
Symbol time freight;
Symbol drop trains;
New York Chicago & St. Louis Railroad.

Total, 3,195 cars.

Two grouping yards;

Car transfer yard;

Hold yard for cripples;

Main assembly tracks for westbound Buffalo local movement;

Westbound reclassificatien yard, preceded by a hump;

Westbound advance yard;

Westbound symbol advance yard.

The eastbound arrangement is on similar lines.

Two New York Central enginehouses are located in about a central position with respect to the westbound classification yard and eastbound advance yard.

Separate car repair shops for eastbound and westbound cars are located parallel to the general axis of the yard and in the immediate neighbourhood of the respective yards.

GARDENVILLE, NEW YORK YARD, NEW YORK CENTRAL & HUDSON RIVER RAILROAD.

Car capacity of body tracks of individual yards.

TERMINAL YARD.

NAME OF YARD.	Eastbound.	Westbound.	Total.
Receiving yard	2,000 cars.	2,000 cars.	4,000 cars.
Classification yard	3,321 —	3,195 —	6,416 —
Reclassification yard	530 —	530 —	1,060 —
Transfer yards	325 —	325 —	65[illegible]
Grouping yards	231 —	231 —	462 —
Icing yard	3[illegible] —	...	30[illegible] —
Car repair yards	5[illegible] —	5[illegible] —	1,1[illegible] —
Cripple hold yard	1[illegible] —	2[illegible] —	4[illegible] —
Assembly yards	344 —	344 —	68[illegible] —
Fuel coal yards	153 —	145 —	29[illegible] —
Caboose yards	86 —	86 —	172 —
Tonnage advance yard	2,000 —	2,000 —	4,000 —
Symbol advance yard	290 —	290 —	580 —
Drop and pickup advance yard	400 —	400 —	800 —
Miscellaneous	195 —	195 —	390
Total	10,855 cars.	10,551 cars.	21,406 cars.

ENGINE YARD.

—	Eastbound.	Westbound.	Total.
Engine houses	70 engines.	70 engines.	140 engines.
Incoming standing tracks	47 —	47 —	94 —
Outgoing — —	16 —	16 —	32 —
Total	133 engines.	133 engines.	266 engines.

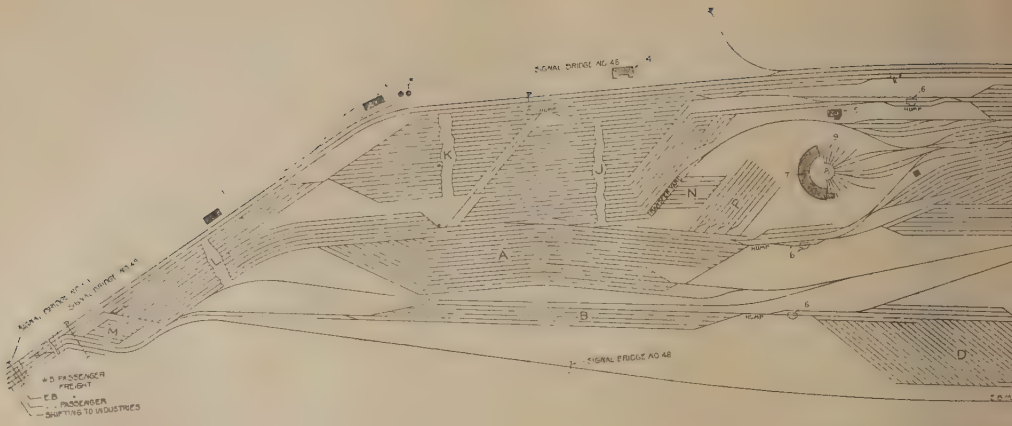


Fig. 12. — Conway Y

A. . . = East bound receiving yard cap. 1,153 cars.
B. . = — — — — — 340 —
C. . = — — classification yard cap. 1,302 cars.
D. . = — — — — — 900 —
E. . = — — storage cap. 649 cars.
F. . = East bound departure cap. 798.
G. . = West — receiving yard cap. 552 cars.
H. . = — — — — — 687 —
J. . = — — classification yard cap. 1,184 cars.
K. . = — — — — — 681 —
L. . . . =
M. . . . =
N. . . . =
P. . . . =
R. . . . =

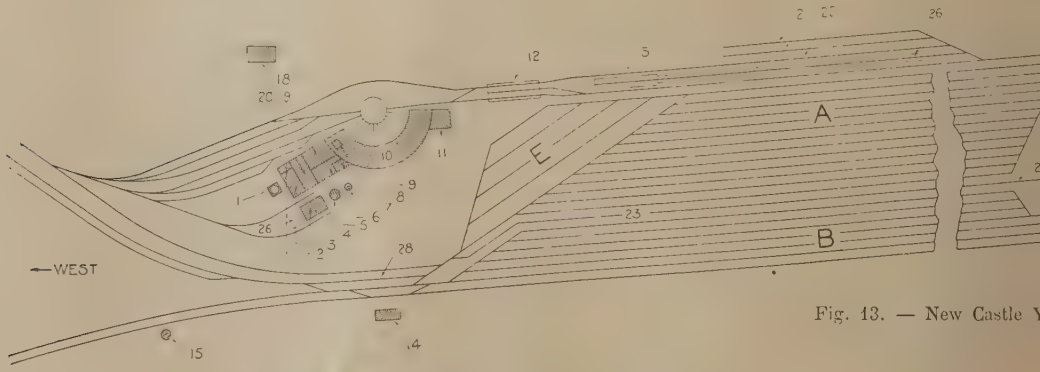
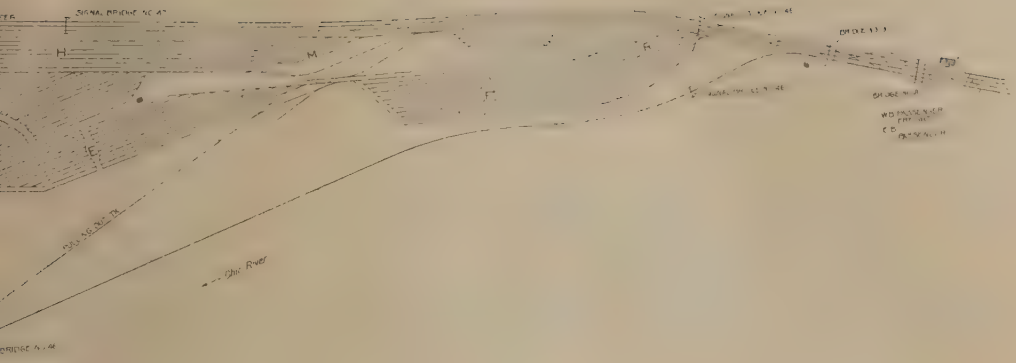


Fig. 13. — New Castle Y

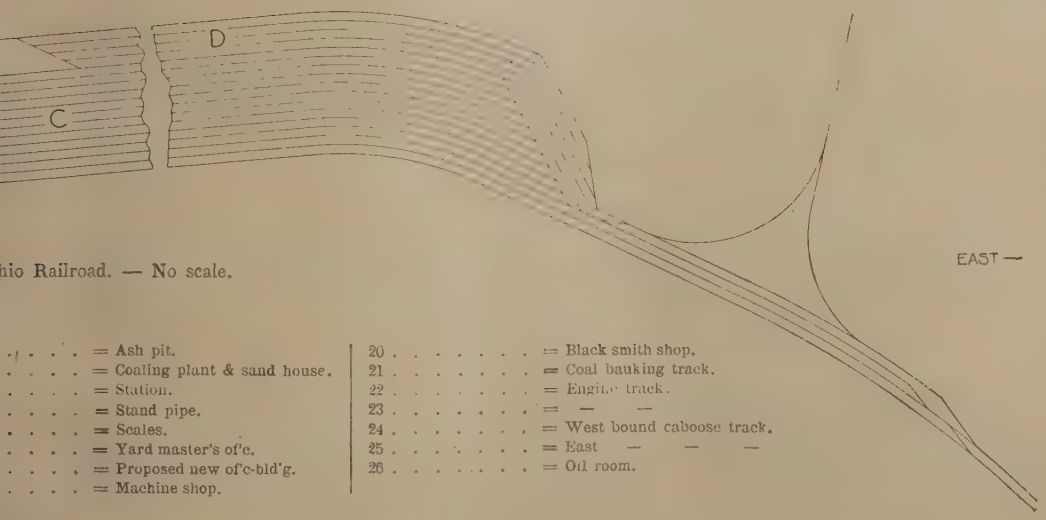
A. . . . . = West bound classification yard.
B. . . . . = East — receiving yard.
C. . . . . = — — classification yard.
D. . . . . = West — receiving yard.
E. . . . . = Car repair tracks.
1. . . . . = Chimney.
2. . . . . = Engine room.
3. . . . . = Boiler room.
4. . . . = Store room.
5. . . . = Hot well.
6. . . . = Hose house.
7. . . . = Slushing tank.
8. . . . = Tool house.
9. . . . = Drop pit.
10. . . . = Round house 20 stalls.
11. . . . = Foreman's office, rest house &



ailroad. — No scale.

cap. 700 cars.
in div.

1. . . . . = Passenger station.
2. . . . . = Freight house.
3. . . . . = Water tubs.
4. . . . . = Rest house.
5. . . . . = Yard office.
6 . . . . . = Scales.
7 . . . . . = Engine house.
8 . . . . . = Turntable.
9 . . . . . = Packing Tks.
10 . . . . . = Coaling trestle.



hio Railroad. — No scale.

. . . . = Ash pit.
. . . . = Coaling plant & sand house.
. . . . = Station.
. . . . = Stand pipe.
. . . . = Scales.
. . . . = Yard master's of'c.
. . . . = Proposed new of'c-bld'g.
. . . . = Machine shop.

20 . . . . . = Black smith shop.
21 . . . . . = Coal hauking track.
22 . . . . . = Engine track.
23 . . . . . = — —
24 . . . . . = West bound caboose track.
25 . . . . . = East — — —
26 . . . . . = Oil room.

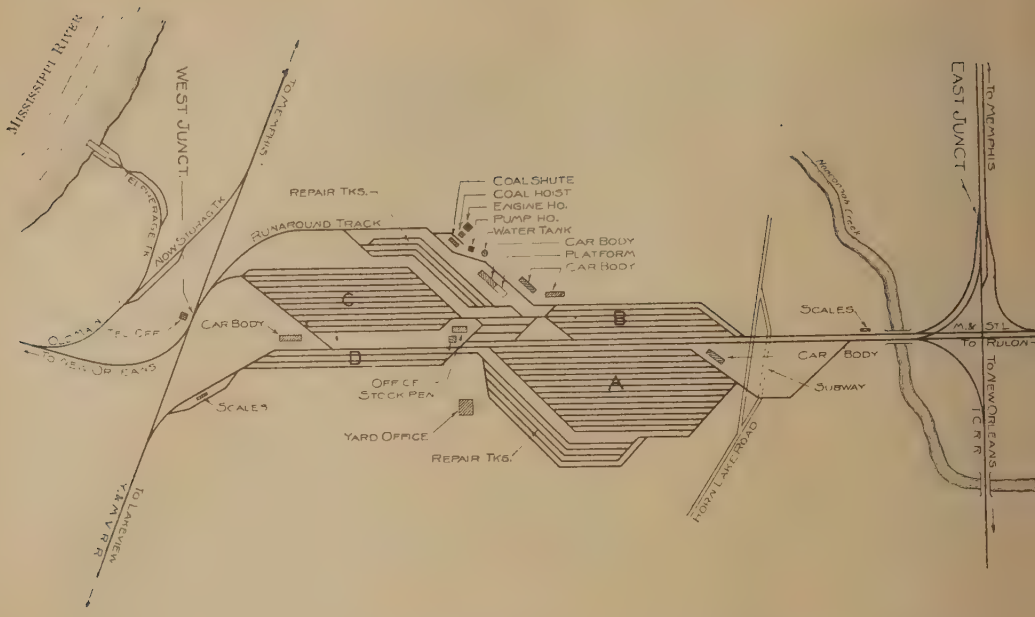


Fig. 14. — Nonconnah Yard, Illinois Central Railroad. — Near South Memphis. — No scale.

A . . . . . = North bound classification yard.
B . . . . . = South bound receiving yard.
C . . . . . = South bound classification yard.
D . . . . . = North bound receiving yard.

C. — CONCERNING LARGE FREIGHT STATIONS.

Question 5. — *Please describe : 1) The appliances which you are now using for handling freight.*

Two types of trucks are in common use : First, a two wheel wooden frame truck. It is of good design and fairly well balanced, and is used at both freight and transfer houses. Plain bearings are now used, but this type of truck is now being experimented with in all steel in three designs, as follows :

One half barrel design, estimated weight.	150 lb.
— — — — —	155 lb.
One full — — — —	156 lb.

The all steel truck is half barrel design. Second : The four wheel truck known as the Reynolds truck is used at many stations. This truck weighs 370 pounds.

The Pennsylvania Railroad is considering a truck similar to the Reynolds truck, which weighs 380 pounds, and is much more substantially built. The rear wheels are located some distance from the end of the truck, and they carry about two-thirds of the load. They have roller bearings. The front wheels or castors are mounted on swivel ball bearings, and the truck is easily turned by one man in any one direction, on its bearings or in its own length, with a load of 2,500 pounds. The cost of this truck is estimated at about $20·50.

For the handling of heavy freight, such as pianos, safes, etc., a six wheel truck is used. The two center wheels are of a slightly larger diameter than the others and are located inside of the frame. This permits the truck to be turned in a very small circle.

Special trucks are in use at some of the larger stations where the character of the freight handled is of such a nature as to demand special devices, such as pipe and plate glass handling trucks. They are rather exceptional, however.

Fixed jib cranes and overhead cranes : The overhead cranes usually span one or more tracks and a driveway. In some cases the bridge is fixed, in others the bridge moves on an elevated track, and in still others the bridge is supported by towers which move on surface tracks. In many instances, the travelling electric cranes are of 30 to 40 ton capacity, with auxiliary hoists of 5 to 7 ½ tons for lighter weights.

In storage warehouses horizontal conveyors (roller, chain, platform) are coming into use, as well as overhead travelling cranes. Likewise, in storage warehouses the carrier systems are proving efficient, especially in long pier houses, where the movements are longitudinal and free from complications. The telferage system, consisting of steel runways on which are operated electric hoists and travellers, is successfully and economically operated in such cases. Vertical elevators, hydraulic and electric, are commonly used. Speed about 20 feet per minute.

The Buenos Aires Great Southern Railway says :

No special devices are in use, except at one or two stations at which there are ordinary traversers and capstans for moving wagons.

Question 3-II. — "*Any experimental devices which you may be trying for handling carload and less than carload freight ; and describe the results obtained as to efficiency and economy of such devices.*"

Plans have been drawn by a number of railroads for improving the methods of handling freight, and, more especially, package freight in city stations. Different arrangements and combinations of trolley systems, industrial railroads, telfer,

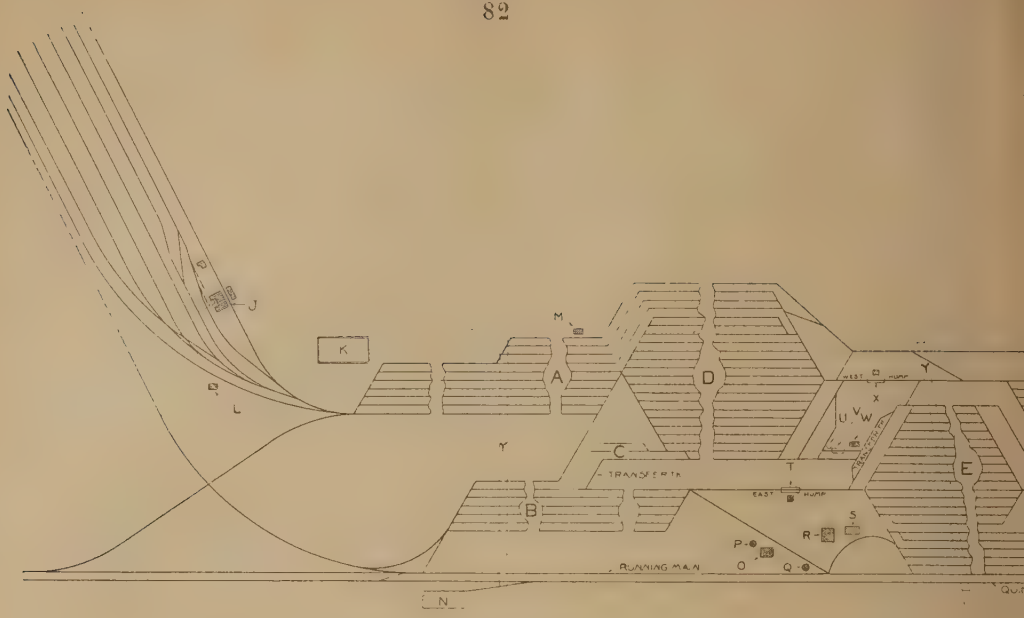


Fig. 15. — Galesburg Yard, Chicago, Burlington & Quincy Railroad. — No scal

Key :

A	= Outgoing south and west 80 car tks.	S	= Lunch room.	11	
B	= Incoming south and west 80 car tks.	T	= Scales.	12	
C	= Light repair yard.	U	= Crane.	13	
D	= Sorting yard 18 tks. 615 cars.	V	= Clinker pit.	14	
E	= Sorting yard 16 tks. 562 cars.	W	= Air hoist.	15	
F	= Outgoing east and north 80 car tks.	X	= Scales.	16	
G	= Outgoing east and north 80 car tks.	Y	= Subway.	17	
H	= Incoming east and north.	1	= Tel. office.	18	
J	= Tie treating plant.	2	= Salt house.	19	
K	= Pond.	3	= Ice.	20	
L	= Sec. house.	4	= Well.	21	
M	= Air compressor.	5	= Clinker pit.	22	
N	= Stock pens.	6	= Wrecker.	23	
O	= Pump house.	7	= Office.	24	
P	= Well.	8	= Paint shop.	25	
Q	= Tank.	9	= Material shed.	26	
R	= Yard office.	10	= Round house.	27	

machines, moving platforms, truck conveyors, etc., have been considered, but little has been actually accomplished. In a particular instance of a two-level city receiving and forwarding station, the manufacturers were able to produce a machine which would move a number of trucks along a floor and up an inclined plane to a second story and discharge the trucks automatically, but the project as a whole has not been successfully accomplished in the case of less than carload freight. This freight varies greatly in weight and bulk, and it cannot be assured that part of the lading will not fall from the truk and stop or wreck the machine; the automatic discharge

of the trucks at a high level requires men to be on hand to relieve the machines and move the trucks promptly to outbound cars; the freight is received from teams in great volume from about 2·00 to 6·00 p. m. In the morning hours little freight is received, but the machine may have to be run the greater part of the day, and the trucking force must be hired for all day. Considering all the complications and costs, it was decided to be better in this particular case to continue to use the old-fashioned hand truck and vertical elevator. This experience may be regarded as typical.

The Baltimore & Ohio Railroad replies :

No experimental devices are being used :

a) Freight is handled exclusively by trucks, except at Locust Point, Baltimore, where we have the telferage electric trolley system, with overhead tracks and hooks by which the freight can be transmitted from one part of the freight house to another;

b) Freight is handled by trucks and elevators, except at grain warehouses, where it is handled by endless belts. Gantry cranes are provided at all freight delivery yards for handling heavy materials.

(Locust Point, however, is not a general receiving and forwarding freight station, but a pier, and the movement is simple.)

The Chicago, Rock Island & Pacific Railway replies :

No experimental device being tried, although we have been studying a method of handling cotton to and from platforms by machinery :

a) We are using platforms with stub end tracks so as to readily unload automobiles either from side doors or end doors; always provide for a crane so as to handle bulk freight to and from wagons; also provide outside platforms so that large and bulky freight can be unloaded onto them and taken away by teams without passing through the freight stations.

b) We do not have more than one floor to our freight houses, except for offices.

The Northern Pacific Railway replies :

No such conditions.

Again, to operate the trolley system requires additional height between floors, in order that the truck or platform when in motion will not be in danger of striking employees ; this adds seriously to the building cost.

The Pennsylvania Railroad has a vertical barrel and package conveyor at its new Duquesne Freight Station, Pittsburgh, but in experience it is found that " it is only practicable to convey barrels and kegs; it is not suitable for packages at all; the maximum capacity we have been able to develop is 300 barrels of sugar 360 pounds each in 70 minutes with 5 men. Our elevators perform the same service in 57 minutes with 4 men. A machine of this type is not economical in a warehouse like ours where such a variety of merchandise is handled; moreover, it is frequently out of gear and cannot be set in motion and shut off instantaneously like an elevator ".

The New York Central & Hudson River Railroad says under II :

None being used experimentally.

a) No mechanical devices, except on open docks, where " fast plants " are used.

b) Elevators and barrel hoists are the only devices used.

QUESTION 6. — *What improvements or developments in the design and general arrangement of large freight stations are being made as the result of the necessity of elevating tracks in large cities or for other reasons?*

The necessity for elevating tracks in cities has brought about freight stations where the track level is on the second floor. This has brought to bear on the freight station problem much study and analysis of conditions tending toward a closer view of design and of operation. With this change has come also the development of storage houses overhead. It has been found advantageous for railroads, in the case of terminal warehouses, to add three or more overhead stories, so as to afford merchants and commission men an opportunity to have their goods stored on arrival and shipped on order; the outbound shipments being loaded into cars and moved out directly from the freight house. In this way cartage is saved, which in large cities amounts to as much as $0·80 per ton. As a result of the necessity for larger buildings, much larger sums in the way of investment are involved. Further, the enormous increase in the volume of freight handled in cities, which grows in rough proportion to the increase in population, has contributed to the same result as the necessity for providing storage facilities. Space and property are more valuable and every square foot must be utilized. Committees are appointed when a large freight station is to be designed, whose duty it is to analyze all the conditions and recommend a station constructed on the best lines for the purpose in view. This brings into the problem the Freight Agent, who will operate the station; the Engineer, who will construct it; the Train Master, who will be concerned in the moving in and out of cars; the Superintendent of the storage warehouse, who is concerned in the speed and economy in moving the freight from the freight house level to the various floors, the storage and safe preservation on those floors, and the subsequent lowering of this freight to the freight house floor for loading into cars and drays. These conditions have led to a study of economical widths, lengths, heights, dimensions of station driveways, paving, track lay-out, position and construction of elevators, improved office arrangements, including mess room, toilet rooms, etc. for the Agent's clerical force (in large stations this runs up to 60 to 90 men), and the cashier's office, where the public transacts its business. The freight houses have been divided into fire proof compartments by means of interior automatically closing doors; overhead automatic sprinkling systems for the extinction of fires have been provided. It has led to a study of door construction, including junction doors; to better ventilation, drainage, and to improved trucking floors. The improved type of floor consists of maple wood, 8 inches by $\frac{7}{8}$ inch, tongued and grooved, laid diagonally on creosoted yellow pine; this rests on sleepers set in sand, tamped clay, or ballast.

*

Close analysis has been made as to the use of improved machinery for handling carload and less than carload freight. As already stated, however, no very definite results have been reached. A very notable tendency is observable in Chicago, where many of the freight stations are connected with a freight tunnel system which runs under the entire business portion of the city, so that the freight on arriving at a railroad station is loaded into a small car of about 2 tons capacity. This is lowered by an elevator to the tunnel level, and is there moved by electric motors to the basement of the consignee. In a similar way, outbound shipments from the basement of the consignor are loaded in these cars and moved through the subways, elevated to the freight floor of the particular railroad and loaded into outbound cars. The natural development of this change will have a large effect on the design of stations as they are remodelled in the future. A similar system is under contemplation for a portion of the business district of New York City.

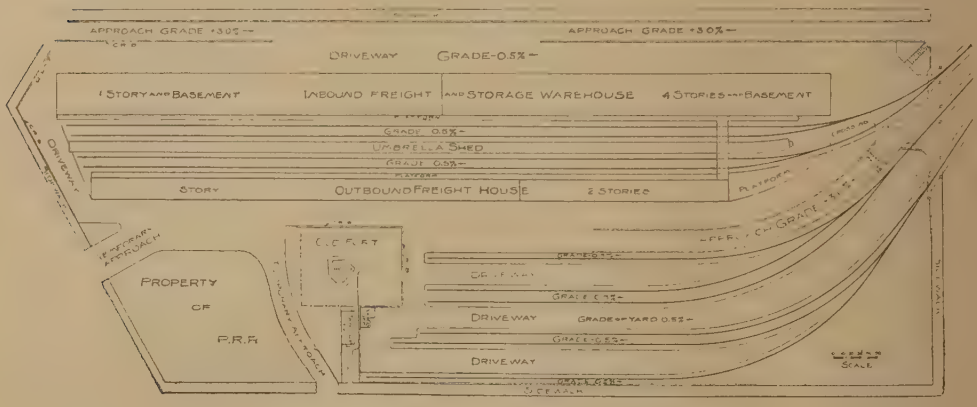


Fig. 16. — Duquesne freight yard, Pennsylvania Railroad.

The old type of freight station consisted of a receiving and forwarding platform, with two or more long tracks, all under one roof. The new type consist of separate inbound and outbound houses, each under a separate roof, with a number of stories for storage purposes over the inbound side. Between these two houses are placed three, four, or more tracks. Between the tracks are placed a number of platforms covered by sheds of improved design, for trucking between the cars.

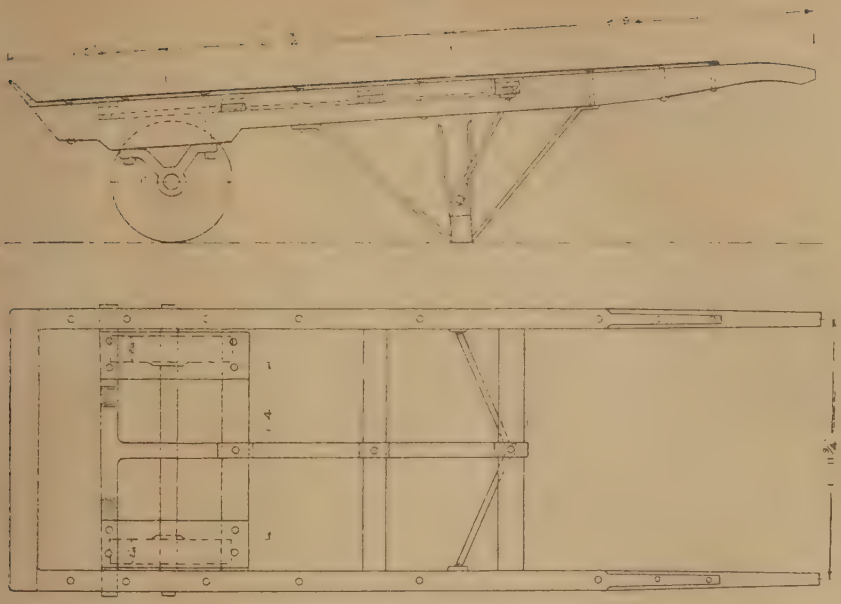


Fig. 17. — Freight truck used at Manua Transfer West Philadelphia Shops, Pennsylvania Railroad.

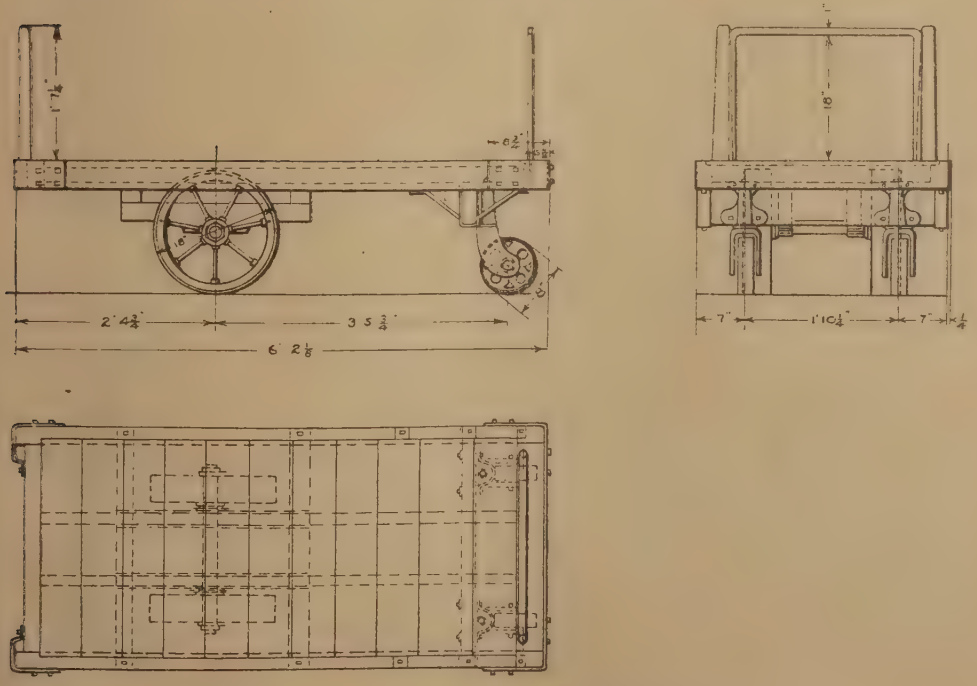


Fig. 18. — General arrangement of four-wheel warehouse truck.

Of the plans appended to this report by the reporter, the following have been reproduced for publication :

FREIGHT STATIONS.

Pennsylvania Railroad.

Duquesne Freight Station, Pittsburgh (fig. 16).

FREIGHT TRUCKS.

Two wheel wooden frame truck used ot Mantua Transfer, Pennsylvania Railroad (fig. 17).
General arrangement of four-wheel warehouse truck (Reynolds type) (fig. 18).

[656 .211 & 656 .212]

REPORT N° 2

(Russia, Austria, Hungary, Turkey, Rumania, Bulgaria and Servia)

By A. KAIN (1),

ENGINEER,

INSPECTOR OF THE HUNGARIAN STATE RAILWAY.

We think it advisable, before dealing with the separate questions and the answers received from the different railway administrations, to give a short account of the development of the railway system and of the traffic in the countries with which our report has to deal.

This short account is intended to elucidate the causes which led to the present more or less satisfactory state of development of the large passenger and goods stations in those countries, and the local conditions and external circumstances, which had a bad influence on the design and construction of the large stations, and finally the opinions and principles adopted by the different railway administrations when designing and constructing large stations in the immediate past.

The chief railway lines, both in Austria and in Hungary, were originally built by a number of separate independent railway companies, and the lines built were more or less competing lines according to their geographical position. The same statement also substantially applies to the other countries with which our report deals.

The passenger and goods stations of the

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(1) Mr. Kain died since his report was sent in.

*

large towns were in most cases combined into one station, in accordance with the needs of the then-existing traffic; but the stations of the different companies were built in different parts of the town. Not only were these separate stations not connected with each other, but the question of facilitating the possibility of making such connections at a future date, should they become necessary, was not even considered.

In this first period of railway development, attention was nearly everywhere paid only to the local importance of the lines, or at most to their importance as regards the country itself.

No provision was made for any connections between the stations at large towns and at traffic centres, made necessary for operating through and international traffic, and thus the larger stations only formed termini of the line concerned.

But as regards the need of a proper through connection of the separate stations in a large town, conditions have now become very much altered, and so have consequently opinions on this point.

Most of the main lines which formerly belonged to companies have in most countries, for instance in Austria, Hungary, Rumania and Servia, become the property of the State; and the lines which are not yet the actual property of the State nearly all fall within the sphere of its influence. Consequently, the need of connecting up the different railway lines, which formed in many cases disjointed sections, became more and more apparent.

Such connections also became indispensable in consequence of the great and unexpected development of the traffic year by year, and in particular that of the through international traffic. The original conception of the nature of railway traffic has accordingly become modified; the frontier of a country is no longer looked upon as a terminal point of the railway but as a transit point, and the terminus proper of the railway is only reached at the seashore, where other means carry the traffic further.

This continual development of the home and of the international railway traffic has made the defects which result from the original design and construction of the large stations very apparent and in some cases even unendurable, particularly those which result from a want of connection between the different stations in one and the same large town.

This makes itself specially apparent in those countries in which the traffic is not uniformly distributed over the whole year, but is chiefly seasonal in its character; it hinders the development of the traffic and consequently also the economical development of the whole country. In addition, these obstacles to the traffic increase the working expenses of the railways and also reduce their capacity and earning power.

But even after these defects and the causes of the evil had been recognized, the work of eliminating them could only unfortunately proceed at a slow rate. There were and still are many more important and urgent requirements in connexion with railways, both from the commercial and industrial points of view, than the eliminating of these defects.

In the first place, there was the construction of new railways, in order to complete the existing railway system and to open up new districts and new sources of natural wealth, and to make as far as pos-

sible all parts of the country equally accessible to the blessings of civilization.

In the second place there was the need, quite as apparent, of providing for the increasing traffic on the existing lines, by enlarging the smaller and the medium-size stations, and by duplicating the tracks.

Only after this work had been more or less completed, was it possible for any of the countries our report deals with to proceed with the extensions of its passenger stations, and to reconstruct them in accordance with modern developments, and also to reconstruct its goods yards and suit them to the growing goods traffic, in order to reduce the working expenses.

As all this work involved a very large outlay, most of the countries could in most cases not proceed beyond the working out of the different schemes, while the carrying out of these schemes will take place in the immediate future. Such is the general state of the question in Russia, Austria and Hungary.

The other countries to which our report applies have not even arrived at this stage, as their whole energy for some time to come will have to be devoted to the construction of the main lines of their railway system.

Passenger and goods traffic, as already stated, has increased during recent decades, and particularly so in Austria and in Hungary.

In Austria, during the last ten years, passenger traffic has increased 50 per cent and good traffic 40 per cent; in Hungary the figures are 75 and 77 per cent respectively.

The railways and their organizations were consequently only able to deal with the growing traffic with safety by making the greatest efforts and by adopting many special measures, often involving much trouble. Among such measures we may mention the increase in the axle-loads of the vehicles and the increase in the speed and the number of the trains; and in order to make this possible, the track was strengthened, the number of passing places was increased, and the existing smaller and medium-sized stations were enlarged.

All this work formed a heavy tax on the resources of the railway administrations.

Particular attention was also devoted to the alteration of the large railway stations at industrial and commercial centres. The general principles on which these alterations were based will be dealt with later on in connection with the separate questions. In these questions, we deal with the passenger stations and the goods stations separately, and we will at once enunciate the principle, already now generally recognized as correct, that the railway traffic at large towns can only be managed quickly and economically, to meet the justifiable demands of the travelling public and of the public interested in the goods traffic, if the passenger traffic and the goods traffic are kept wholly separate. On the other hand, the mails and the quick-freight service are in close connection with the passenger service, as in the countries this report deals with nearly the whole of this traffic is still operated conjointly with the passenger traffic.

It is desirable in the interests of the public, that the large passenger stations should be placed as nearly as possible at the centre of the population according to its distribution.

If the town is a very large one, it is pro-

bably best to have several passenger stations in the different parts of the towns, all in communication with each other and serving for all traffic relations, so that the whole population may be enabled to reach a station with as nearly equal ease as possible.

If there is one central station for the whole town, which hardly would suffice for the traffic in a larger town, it is necessary to have special sorting stations, for sorting and marshalling the passenger trains, as near as possible to the central station, so as to reduce as much as possible the distance the trains requiring sorting have to run.

Such a main or central station will in most cases be in the form of a terminus, and will be supplied, with a view to future requirements, with a large number of halls and platform sidings.

The special sorting stations mentioned, with their extensive sidings and locomotive sheds, are indispensable for sorting and marshalling passenger-train stock, for storing any carriages which have to be added to through trains and any carriages not required at the time, and for changing the locomotives. It is consequently also desirable in the interests of quicker operation that these sorting stations should be as near to the passenger stations as possible.

It is a great advantage if these sorting stations can be placed between the main lines, in order that trains coming from the passenger station to the sorting station, or trains leaving the sorting station and going to the platform sidings, may not have to cross the main lines.

This principle should not be departed from except if the crossing of the main lines at rail-level can be wholly avoided by means of overbridges and underbridges.

If in a large town there are to be several passenger stations in through connection with each other, then a special auxiliary station should be installed at each of two opposite points on the boundary of the town. These auxiliary stations are then the terminal stations of the trains and are to be used as the departure and arrival stations for the adjoining outer parts of the town. The sorting stations mentioned above must in this case be built in connection with the auxiliary stations.

The installations for dealing with the mails and the quick-freight traffic are also best placed at these auxiliary stations, at least in those countries where (as in the case of the countries with which this report deals) the mails and the quick-freight are conveyed by the passenger trains, as the mail and quick-freight matter can in this way be brought conveniently to the passenger trains.

The through lines in the town, connecting the passenger stations and the auxiliary stations, should be either underground or elevated railways, in order not to interfere with the street traffic of the town; and for the same reason, the sidings of the passenger stations should also be above or below street level.

The goods stations, which should be quite separate from the passenger stations, should as far as possible be accessible from the town. But just as in the case of the auxiliary stations and the sorting stations, these goods stations must be located outside the city limits proper, both on account of their large extent and the consequent large expenditure on land, and

because they would interfere with the development of the city.

But the further the goods station from the town, the greater the cost of carriage to and from the station; there is consequently a justifiable tendency to place the goods station as near as possible to the more densely-populated parts of the town, and near to the industrial and commercial districts, to suit the existing conditions.

The sorting and shunting yards must however in all cases be placed outside the populated districts, where land is cheaper and no consideration has to be paid to the surroundings and where consequently in designing the installations attention can exclusively be paid to the proper quick and economic operation of the traffic.

It is self-evident that the sorting and shunting yards should have a short and as convenient a connection with the goods stations as possible, and if necessary also with the passenger stations.

In large towns, where there are several goods stations, it is advisable to have a central sorting and shunting yard as the freight carried on the different railway lines usually includes a good deal of through freight, which if there is more than one sorting and shunting yard would in most cases have to be taken from one to the other. In addition many consignments are handed in at the different goods stations which would not be added to the corresponding train at the adjoining sorting and shunting yard but at one further off. This would result in much unnecessary work and additional expense, and the junction lines would tend to become congested; all this can be avoided by having one central sorting and shunting yard only.

The above-mentioned separation of the passenger stations and of the installations for dealing with goods has however only its full effect in cases where there are already separate lines for carrying the passenger and the goods trains. This can however only be the case where there is much traffic. It is however absolutely necessary that the tracks should be separated in this way at least as far as the next stations.

At large towns where the coal required for the use of the inhabitants is stored, in the absence of other installations, at the stations, it is very advisable to construct special coal yards, of suitable design.

At many of the large stations in the countries our report deals with, the passenger, goods and sorting stations were rebuilt during the last ten years, the principles enunciated above being adopted either wholly or partially. At other stations this transformation has been begun or is going to be begun, in other cases the plans have been worked out.

The questions arising in this connexion will be considered separately in the following sections of this report.

A. — Large passenger stations.

Question 1. — *Have you adopted special arrangements in order to increase the working capacity of your stations and to ensure the safety of the shunting operations? More especially : a) Are the tracks for main-line trains grouped together in a set separate from the set of tracks used for suburban trains?*

A busy short-distance traffic can, as a rule, only exist in the case of very large

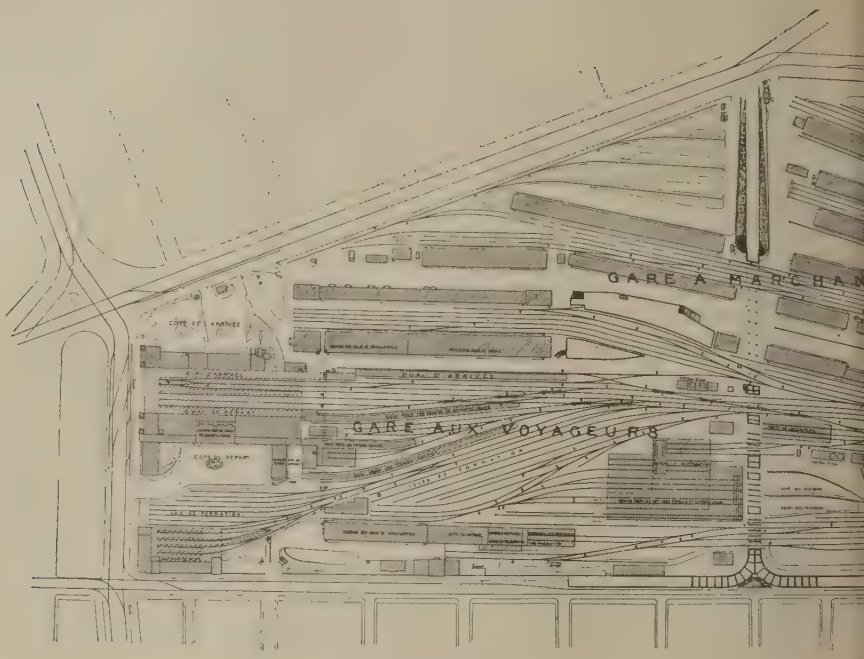


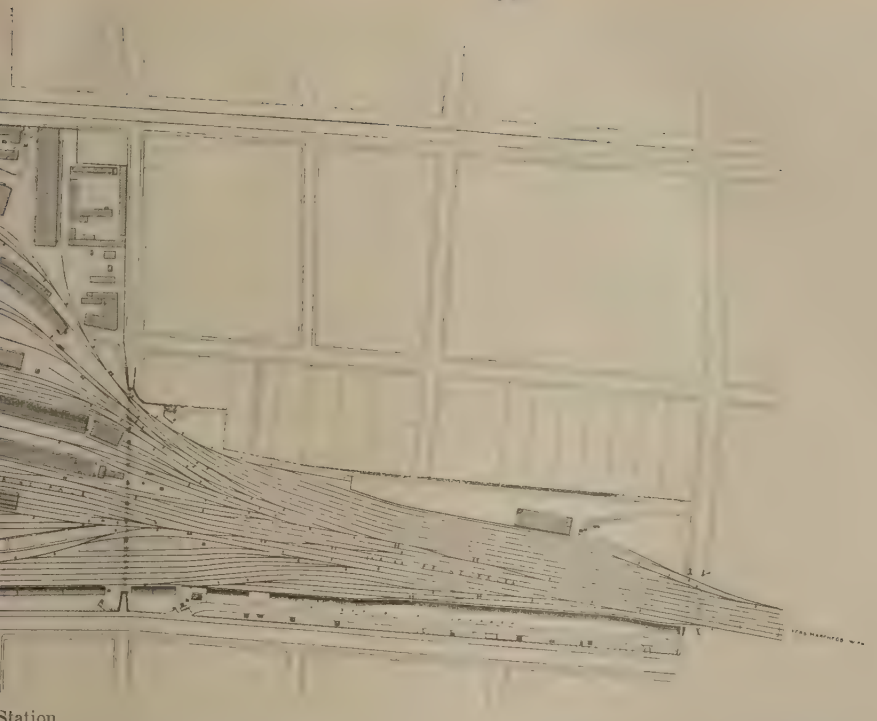
Fig. 1

Explanation of French terms : Côté de l'arrivée = Arrival side. — Quai d'arrivée = Arrival platform. — Quai
= Post-office building. — Quai pour les trains de grandes lignes = Platform for main-line trains. — Quai p
yard. — Dépôt des charbons = Coal store. — Dépôt de locomotives = Locomotive sted. — Voie principale =
Glissoir à charbon = Coal shoots.

towns. In the countries with which our report deals the suburban traffic of these towns is only in part operated on the main lines and only in so far as the lines to the passenger stations in the large towns also carry a large number of local trains. This is for instance the case in Austria on the lines to Vienna, particularly on the Vienna-Mürzzuschlag line; in Hungary on the Budapest-Párkánynána, the Budapest-Szolnok, the Budapest-Bicske and other lines. At present there are two chief passenger stations at Budapest, where the daily traffic amounts to about 300 passenger trains; 130 of these are local and suburban trains. The local trains of course stop at each station and even at each halt.

But there are also shorter railway lines which go to the large towns, which carry no long-distance traffic; but the trains on them as a rule also use the passenger stations of the railroads. Such are for instance in Hungary the Budapest-Esztergomer and the Budapest-Lajosmizse-Kecskeméter lines, which all go to the Budapest West station.

Finally, there are also at these large towns shorter railway lines which are



Station.

latform. — Côté du départ = Departure side. — Voies de formation = Marshalling siding. — Bâtiment de poste = Platform for local trains. — Gare aux voyageurs = Passenger station. — Gare aux marchandises = Goods rincipales = Main lines. — Château d'eau = Water-tower. — Vers Marchegg-Wien = To Marchegg-Vienna. —

quite independent of the main lines, which are also exclusively used for short-distance traffic, but do not touch the passenger stations of the main lines, and have their own local stations as termini. To this class belong for instance the local lines Budapest-Haraszti, Budapest-Czinkota, Budapest-Szentendre and Budapest-Nagytétény, most of which have no connection whatever with the tracks of the passenger stations of the main railroads.

To a certain extent the Vienna Stadtbahn was also built for this purpose, although its chief object was to carry city traffic proper.

Special sets of tracks reserved for short-distance traffic are only to be found in very few stations in the countries with which our report deals; for instance in Triest and Salzburg.

The explanation for this fact is that at the time when these passenger stations, such as all Vienna and Budapest passenger stations and others, were built, the short-distance traffic was still in a very elementary condition and it was consequently unnecessary to devote special tracks to it.

Later on however, when short-distance

traffic in most of the large towns had become enormously developed, and it would have been desirable to have such installations, these could only have been constructed with much difficulty, owing to want of room and the great expense involved in extending any station which is inside a large town.

Any such extension of a large station is made particularly difficult by the circumstance that such a station forms a natural centre of attraction and soon becomes surrounded by new hotels, banks and industrial establishments.

Hence attemps were made to deal with the short-distance traffic, at least for a time, by means which did not involve building operations, so that the short-distance and the long-distance traffic could still be operated, at least for the time being, on one and the same set of tracks.

Such an expedient for instance consists in running the local trains at other hours than the long-distance trains, so that both can use the same sets of tracks; the latter trains chiefly use the large stations between 5 and 10 a. m., 12 and 3 p. m., and 6 and 11 p. m. This division we find at the large stations of most countries.

Another expedient we find for instance on the Vienna-Triest line of the Austrian Southern Railway; the long-distance trains and the Vienna local trains arrive and depart on the same set of tracks at the Vienna South station. On Sundays and holidays, when the ordinary number of local trains no longer suffices for dealing with the enormous local traffic, some of the long-distance trains are taken from Vienna to Vienna Neustadt over the single-track line Vienna Pottendorf-Vienna Neustadt, in order to leave the two tracks of the main line wholly free for additional local trains.

Most of the passenger stations at Vienna already belong to the State (State, North, North West, West, and Franz-Josef stations); these terminal stations have no connection. In this case it is possible, and intended, either to replace these terminal stations by new stations properly connected together, or to reconstruct the stations and make proper connections between them. If this plan is carried out, it is certain that special sets of tracks for local trains will be provided in the case of those lines which carry a heavy local traffic.

It becomes still easier to operate the traffic if in addition to the tracks at the stations, special tracks are also reserved on the open line for the local traffic and especially for the long-distance traffic. In most cases, it will however hardly be possible to do so and one will be limited to having separate tracks for the short-distance and the long-distance traffic at the stations.

The passenger stations at Budapest, the West and East stations, were built at different periods, by different owners, and had no connexion with each other. Today these chief stations are the property of the State and both are also used by through international trains, which carry the passenger traffic between the East and the West.

At both the West station (fig. 1) and at the East station (fig. 2), in Budapest, the station buildings and the tracks are at present being altered, so that separate sets of tracks will soon be available for the long-distance traffic and for the short-distance traffic. On the arrival side of the former station, local conditions will how-

ever make this separation impossible.

The alterations at these two stations, which are nearly completed, had however only the object of reducing the difficulties in connexion with the passenger traffic in the capital city of Hungary, at least until the general reconstruction of Budapest stations can be carried out; the plans for this have been prepared and part of the scheme has already been begun.

The two stations are comparatively small, and have four and five tracks respectively; they accommodate nearly 300 trains per day. The total number of passengers at the two stations amounted in 1908 to about 19 millions, and the average annual increase varies between 1·5 and 2 millions.

The scheme for reconstructing the passenger stations includes the construction of an auxiliary station in the northern suburbs and of another in the southern suburbs, at suitable spots, each connected with a sorting station with the necessary installations for operating passenger traffic.

In addition to these auxiliary stations and the sorting stations connected with them, it is proposed to build inside the town two other chief passenger stations (through stations) in suitable positions and at a suitable distance from each other. All these stations are connected in such a way that trains for any destination can be boarded from either station and also can arrive there from any destination.

The tracks used for the long-distance trains will also be used for some of the short-distance trains except as regards certain local and short-distance trains for which two special tracks will be provided.

In this way both the local traffic and the short-distance traffic will be partly separated from the long-distance traffic, but they will still remain in contact with each other. The diagram (fig. 3) shows how it is proposed to operate the passenger traffic.

Another circumstance worth mentioning is that the tracks exclusively used for short-distance traffic, which enter the passenger stations of the large towns, but are otherwise quite independent of the main lines used for the long-distance traffic, were originally connected with the main lines immediately before the entrance of the station. This arrangement had the disadvantage, that at this end of the station it was accordingly only possible to receive or dispatch one train at a time in either direction, and this hampered not only the work at the station, but also the traffic on the main lines going to the station. Hence it is now the practice, whenever large stations are reconstructed, to keep the track for the short-distance traffic separate from the main lines at the entrance to the station; in the latter separate platform are provided for each direction and it is then possible to receive and dispatch at one and the same end, or at both ends, at the same time, trains from or to various directions.

Such a scheme has been fully carried out in Austria at Lemberg station (fig. 4), Austrian State Railway; it is at present proposed to proceed in this way in the case of the reconstruction of a number of large stations on the Hungarian State Railway, for instance at Szolnok (fig. 5), Kassa (fig. 6) and Zombor (fig. 7).

The dispatch of trains can also be facilitated, as at many stations of the Austrian State Railway, by having an island plat-

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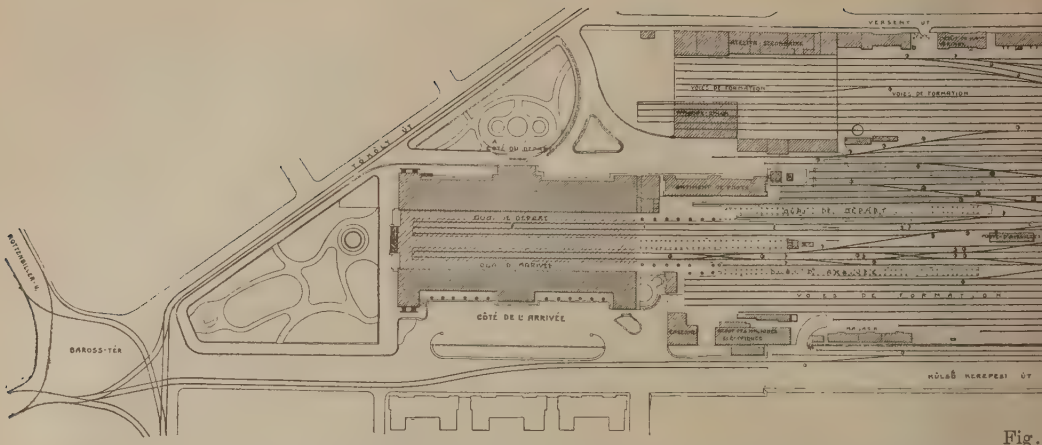


Fig.

Explanation of French terms : Côté du départ = Departure side — Quai de départ = Departure platform. —
formation = Marshalling sidings. — Wagons-salons = Saloon carriages. — Bâtiment de poste = Post-offi
Usine à gaz et huile = Gas and oil works. — Magasin = Warehouse. — Poste d'aiguilles = Switching p

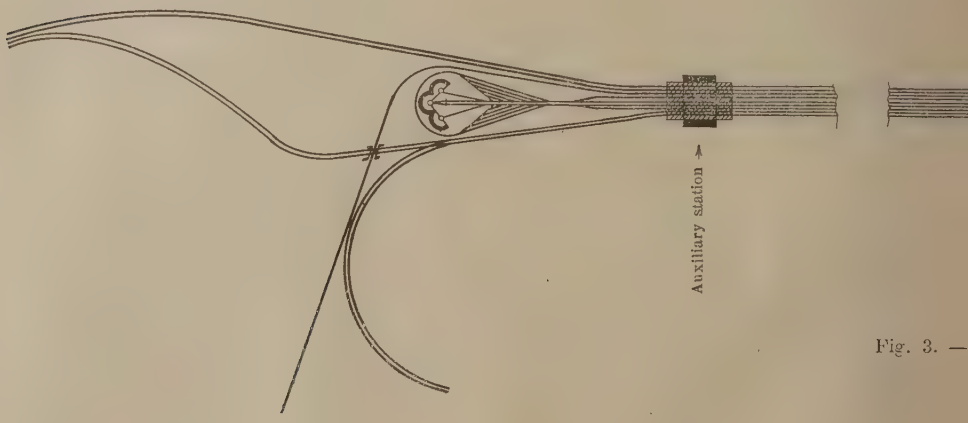
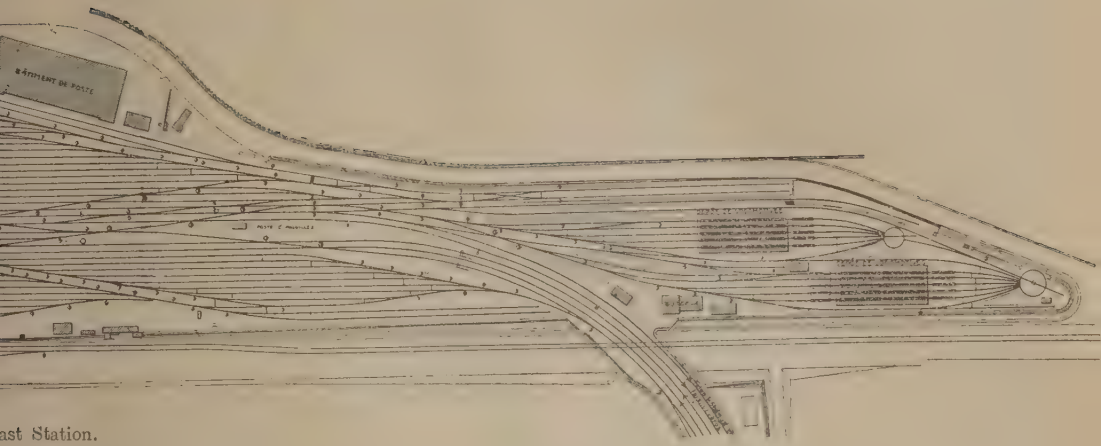


Fig. 3. —

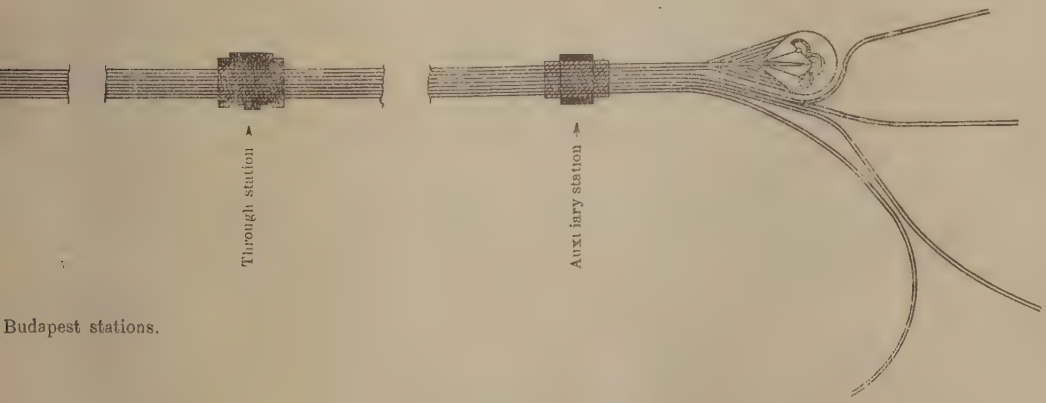
form, with bays or projecting platforms at each end, which are used for the departure and arrival of short-distance trains. Such an arrangement is to be found for instance at Bischofshofen (fig. 8) and at Salzburg (fig. 9).

According to information supplied by the administration of the Syzran-Viazma Railway (Russia), the tracks used for the long-distance traffic and those used for the short-distance traffic are not kept separate at the large station but the tracks are grouped in sets according to the direction of the trains. The individual separate



ast Station.

Arrival platform. — Côté de l'arrivée = Arrival side. — Atelier secondaire = Secondary workshops. — Voies de
ie = Staff quarters. — Dépôt des machines électriques = Electrical machinery. — Dépôt de matériaux = Store. —
ffice. — Dépôt de locomotives = Locomotive sheds.



Budapest stations.

groups are used for all the trains of the same direction.

The administration of the Riazan-Ural Railway (Russia) states that at their larger stations the short-distance traffic has no special set of tracks reserved for it, as it is comparatively unimportant; they are satisfied with having one special track for the traffic at the station in question, generally in the form of a dead-ended siding separate from the other platform sidings. Separate arrival and departure tracks are of course provided for the long-distance traffic.

The same arrangements are to be found on the Russian North Western Railway.

On most of the railways in the other countries to which our report applies, which we have not yet mentioned here, the short-distance traffic is at an early stage of its development, so that it has not yet been necessary to provide any special installations for it.

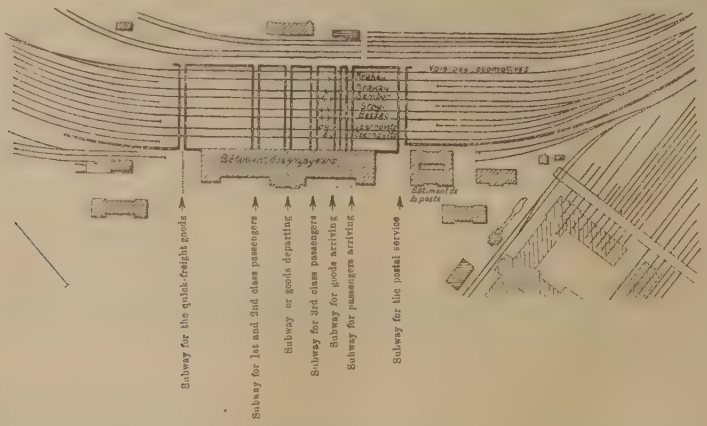

Subway for the quick-freight goods
Subway for 1st and 2nd class passengers
Subway for goods departing
Subway for 3rd class passengers
Subway for goods arriving
Subway for passengers arriving
Subway for the postal service

Fig. 4. — Lemberg station.

Explanation of French terms : Bâtiment des voyageurs = Passenger-station building. — Bâtiment de la poste = Post-office building. — Voie des locomotives = Locomotive track.

Question 1-*b*. — *Are the suburban tracks arranged so as to reduce shunting operations to a minimum? Have you for instance adopted, as the solution, end loops at certain stations, as at Boston station (U. S. A.)?*

As the preceding information shows, installations of different kinds, for dealing with the suburban traffic, are to be found on the railways of the countries to which our report applies. At some stations, the short-distance traffic is operated on the same station tracks which are used by the long-distance trains; at other stations, there are separate departure and arrival tracks for the long-distance traffic and again separate tracks for the short-distance traffic.

Then there are sections which carry short-distance traffic only, but with their lines joining the main lines used for the long-distance traffic immediately in front of the chief stations; and their traffic enters the stations on these main lines. Finally and quite recently, there are also lines used for short-distance traffic, which have their own tracks right into the stations.

The trains for this short-distance traffic are in all these cases so arranged that it is unnecessary to alter the order of the carriages at the station which forms the ter-

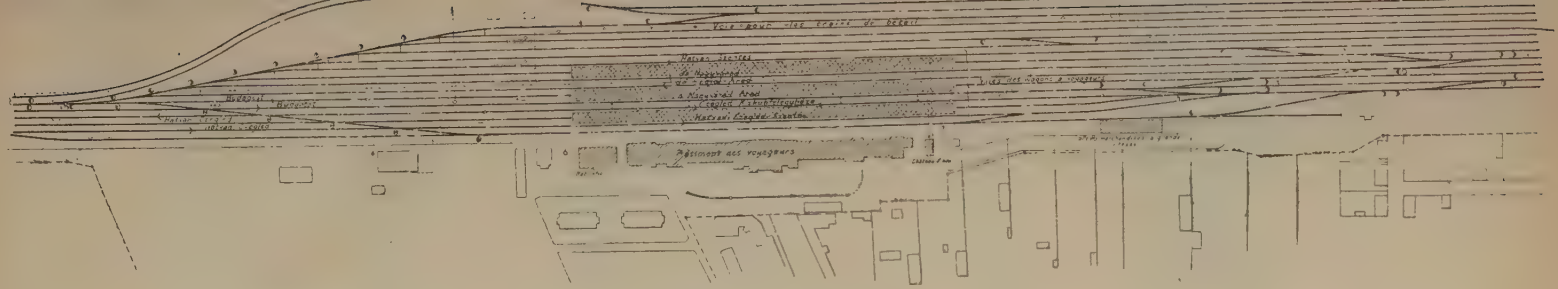


Fig. 5. — Szolnok station.

Explanation of French terms: Voie pour les trains de bestiaux = Track for cattle trains. — Voies des wagons à voyageurs = Tracks for passenger carriages. — Château d'eau = Water-tower. — Halle des marchandises à grande vitesse = Quick-freight building. — Bâtiment des voyageurs = Passenger-station building. — Habitation = Dwelling-house. — Poste d'aiguilles = Switching cabin.

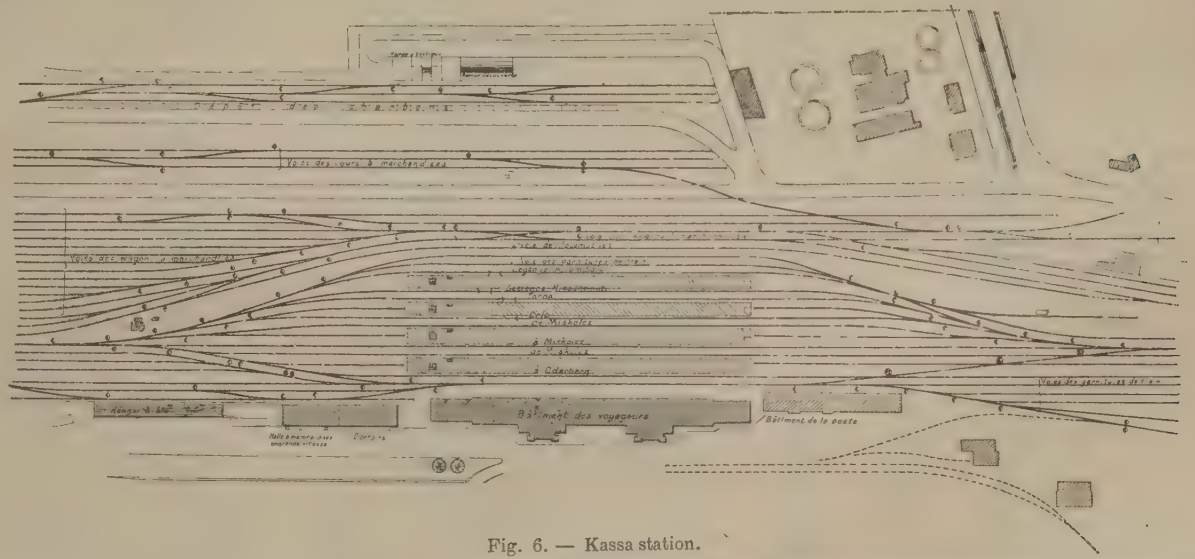
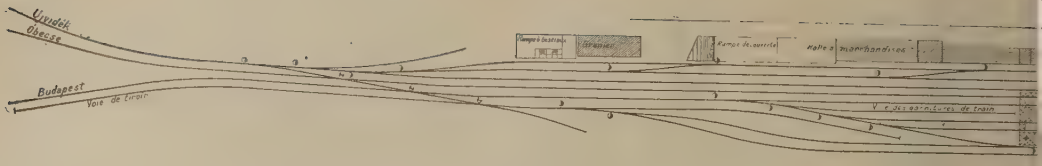


Fig. 6. — Kassa station.

Explanation of French terms: Rampe à bestiaux = Cattle ramp. — Rampe découverte = Open ramp. — Dépôt des charbons = Coal store. — Voie des cours à marchandises = Sidings for loading wagons. — Voies des wagons à marchandises = Sidings for goods wagons. — Voie des locomotives = Siding for locomotives. — Voie des garnitures de train = Sidings for made up trains. — Hangar à blé = Wheat sheds. — Halle à marchandises en grande vitesse = Quick-freight building. — Dortoirs = Sleeping quarters. — Bâtiment des voyageurs = Passenger-station building. — Bâtiment de la poste = Post-office building.



Explanation of French terms : Rampe à bestiaux = Cattle ramp. — Grenier = Store-house. — Rampe découverte = Open ra
Bâtiment des voyageurs = Passenger-station building. — Voies d

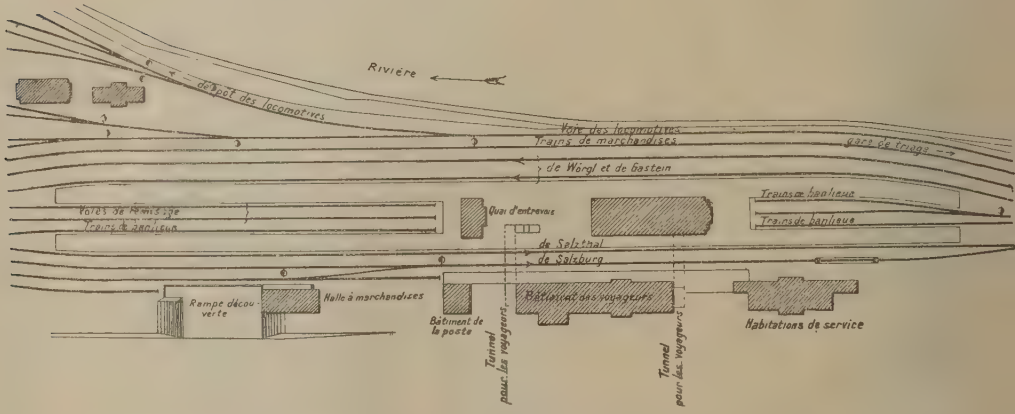


Fig. 8. — Bischofshofen station.

Explanation of French terms: Rivière = River. — Dépôt des locomotives = Locomotive shed. — Gare de triage = Sorting yard. — Trains de banlieue = Suburban trains. — Voies de remisage = Train sidings. — Rampe découverte = Open ramp. — Halle à marchandises = Goods shed. — Quai d'entrevoie = Island platform. — Voie des locomotives = Locomotive siding. — Trains de marchandises = Goods trains. — Bâtiment des voyageurs = Passenger-station building. — Habitations de service = Staff quarters. — Bâtiment de la poste = Post-office building. — Tunnel pour les voyageurs = Subway for passengers. — de = from. — et de = and from.

minus of the line in question. The locomotive and the luggage van behind it are uncoupled from the head of the train, and then coupled up again at the other end; the train can then at once be used for the return journey.

If the same locomotive is not used for the return journey, that locomotive and

station.

handises = Goods sheds. — Voie des garnitures de train = Sidings for made-up trains. — Habitations de service = Staff quarters.
dises = Sidings for goods trains. — Voie de tiroir = Draw-out track.

the luggage van are in some cases left at the end of the train which is to depart, until another locomotive and luggage van have been coupled up to the train and the train has departed.

The latter procedure is naturally only advisable, when very little time is available between the arrival and the departure of the train. In other cases, at most of the large stations the locomotive is transferred by means of a turntable, a traverser or a simple cross-over to an unoccupied track, so that it can then go either to the locomotive sheds or to the head of the train it is to haul.

In a few cases, matters are arranged so that the luggage van is at the head of the train when this is running in the one direction, and at the tail when it is running in the reverse direction. It is then unnecessary to shunt the luggage van, and on lines of minor importance the locomotive in such cases runs backwards in the one direction.

Some short-distance trains, which only have 5 to 10 minutes at the large stations between arrival and departure, have two luggage vans, one at the head and one at the tail of the trains, and these are used alternately for the luggage according to the direction of running. In this case, it is only necessary to shunt the locomotives.

The solution adopted in Boston, underground end loops being used for the local trains, has as yet not been applied in the countries with which our report deals.

An arrangement of loops similar to that in use at Boston is proposed for the new Budapest stations, as shown in the diagram figure 3. A double-track loop passes round the sorting station, which is connected with the sidings at that station. Similarly, figure 10 shows the general arrangement of an auxiliary station with the sorting station belonging to it, and also the locomotive sheds and the other installations not in direct connexion with our subject. The arriving trains run round the loop on to the sidings on

the departure side, and are at once ready for starting; shunting operations are in this way avoided.

Question 1-c. — *How are the tracks arranged so as to make it possible :* I. *To change locomotives quickly;* II. *To add or take off carriages;* III. *To make up passenger trains, or bring to the platform train made up on a special set of sidings?*

I and II. — As already mentioned, at terminal stations the locomotives of the trains which have arrived are transferred by means of a turntable or traverser or cross-over at the end of the platform track to an unoccupied track from which they can reach the locomotive sheds.

Turning the locomotives by means of turntables is a troublesome operation which is always becoming more difficult owing to the continual increase in the length of the locomotives.

The use of traversers, whether at rail-level or sunk, is troublesome at stations where there is much traffic, and even becomes dangerous if the traversers are not accurately adjusted.

If cross-overs are used, a rather large fraction of the utilizable length of the station tracks is lost, which is of considerable importance as the station halls are of limited length.

In spite of this, many of the older stations have to depend on such devices exclusively. Thus we find turntables at the inner ends of several Vienna stations. At the Budapest West station there are however several at the outer end of the station hall; they are used for adding or taking off individual carriage, and will be removed in the course of the alterations which are now being carried out.

At Budapest West station there are in addition intermediate tracks between the platform tracks, which are used for locomotives running out of the station.

In consequence of these difficulties the devices in question have not been put in at some of the most recent terminal stations. Thus for instance the sidings of the new Triest station of the Austrian State Railway (fig. 11) are simply dead-ended, without any such provision. The locomotive of a train which has arrived consequently does not become free until the train itself has been taken out of the station.

In the countries to which our report refers, the railway administrations are generally speaking of the opinion that this problem can only actually be wholly solved at through stations, where the locomotives can run to the sheds on separate tracks specially provided for the purpose.

Such arrangements are now in the course of construction at many stations; in Austria for instance at the Salzburg (fig. 9), Linz (fig. 12), Pilsen (fig. 13) and Budweis passenger stations; in Hungary at Szolnok (fig. 5), Győr (fig. 15), Püspökladány (fig. 16), Zombor (fig. 7), Czegléd (fig. 17), Kassa (fig. 6), Ersekujvár (fig. 18), Vinkovce (fig. 19) and Királyháza (fig. 20) stations; in Russia at Wilna station (fig. 21).

In order to make it possible to provide locomotives quickly for the departing trains, it is also necessary that the locomotives should be able to reach the head of the departing train from the locomotive sidings by means of tracks which must be

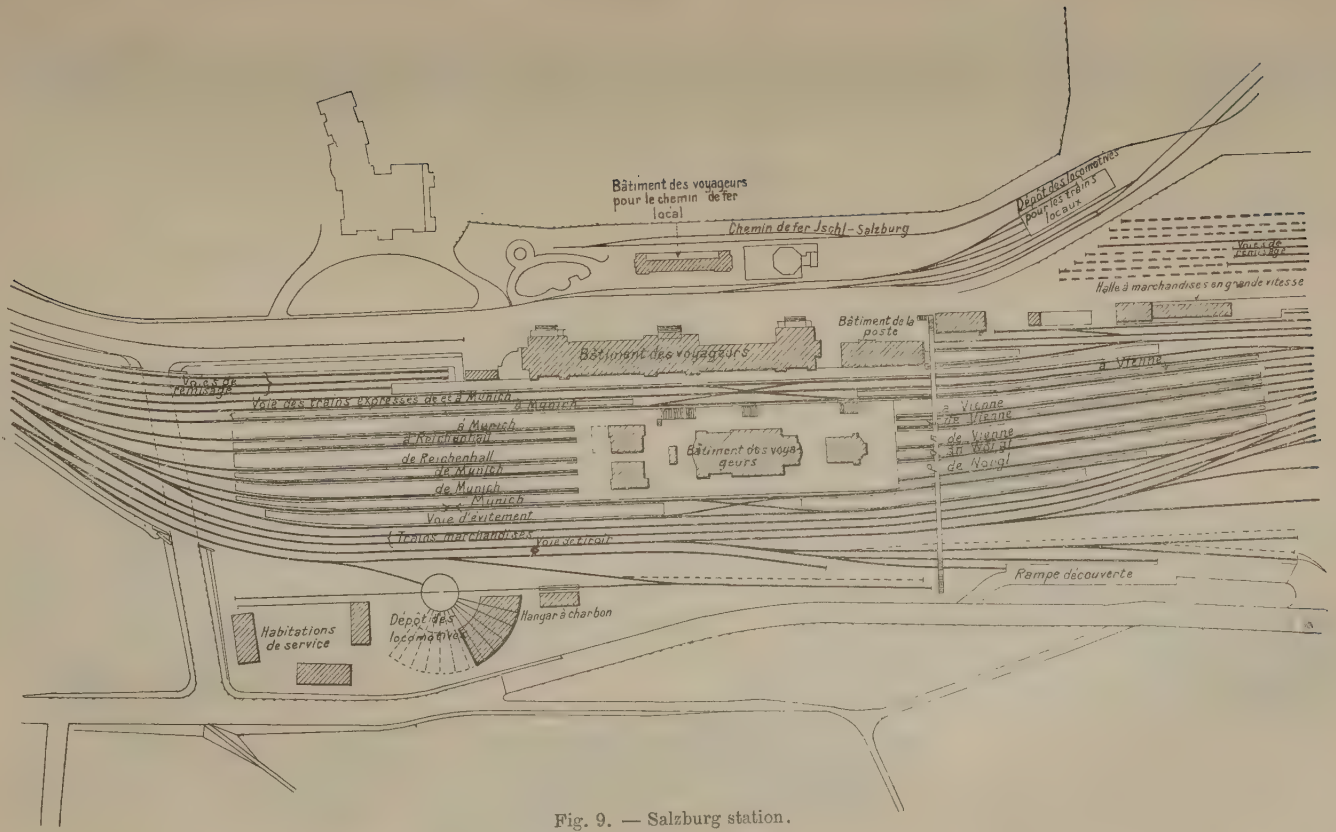


Fig. 9. — Salzburg station.

Explanation of French terms : Voies de remisage = Train sidings. — Bâtiment des voyageurs pour le chemin de fer local = Passenger-station building for the local line. — Bâtiment des voyageurs = Passenger-station building. — Chemin de fer Ischl-Salzburg = Ischl-Salzburg line. — Bâtiment de la poste = Post-office building. — Dépôt des locomotives pour les trains locaux = Locomotive shed for local trains. — Halle à marchandises en grande vitesse = Quick-freight shed. — Rampe découverte = Open ramp. — Voie d'évitement = Shunting siding. — Trains de marchandises = Goods trains. — Voie de tiroir = Draw-out track. — Habitations de service = Staff quarters. — Dépôt des locomotives = Locomotive shed. — Hangar à charbon = Coal shed. — Voie des trains express de et à Munich = Track for the express trains to and from Munich. — Pont = Bridge. — de = from. — à = to.

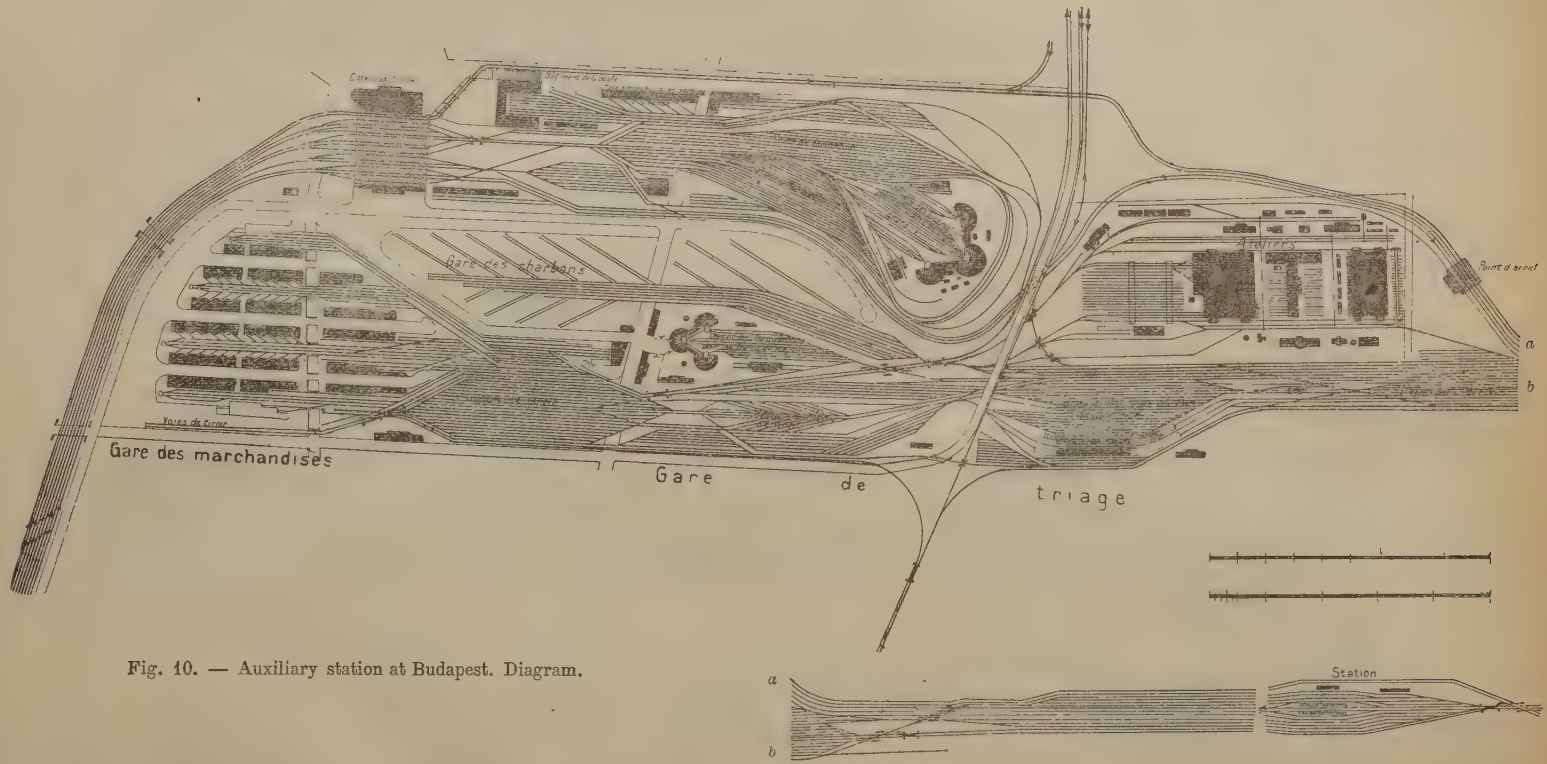


Fig. 10. — Auxiliary station at Budapest. Diagram.

Explanation of French terms: Station = Station. — Voies de tiroir = Draw out tracks. — Gare des marchandises = Goods yard. — Gare auxiliaire = Auxiliary station. — Gare des charbons = Coal yard. — Faisceau de sortie = Departure sidings. — Bâtiment de la poste = Post-office building. — Halle à marchandises en grande vitesse = Quick-freight shed. — Voies de formation = Marshalling sidings. — Dépôt des locomotives pour les trains de voyageurs = Locomotive shed for passenger trains. — Ateliers = Workshops. — Point d'arrêt = Halt. — Dépôt des locomotives pour les trains de marchandises = Locomotive shed for goods trains. — Voies de classement = Sorting siding. — Faisceau de triage A B vers la direction = Gridiron for sorting according to direction. — Hangars de transbordement = Tranship sheds. — Faisceau d'arrivée = Reception sidings. — Gare de triage = Sorting and shunting yard.

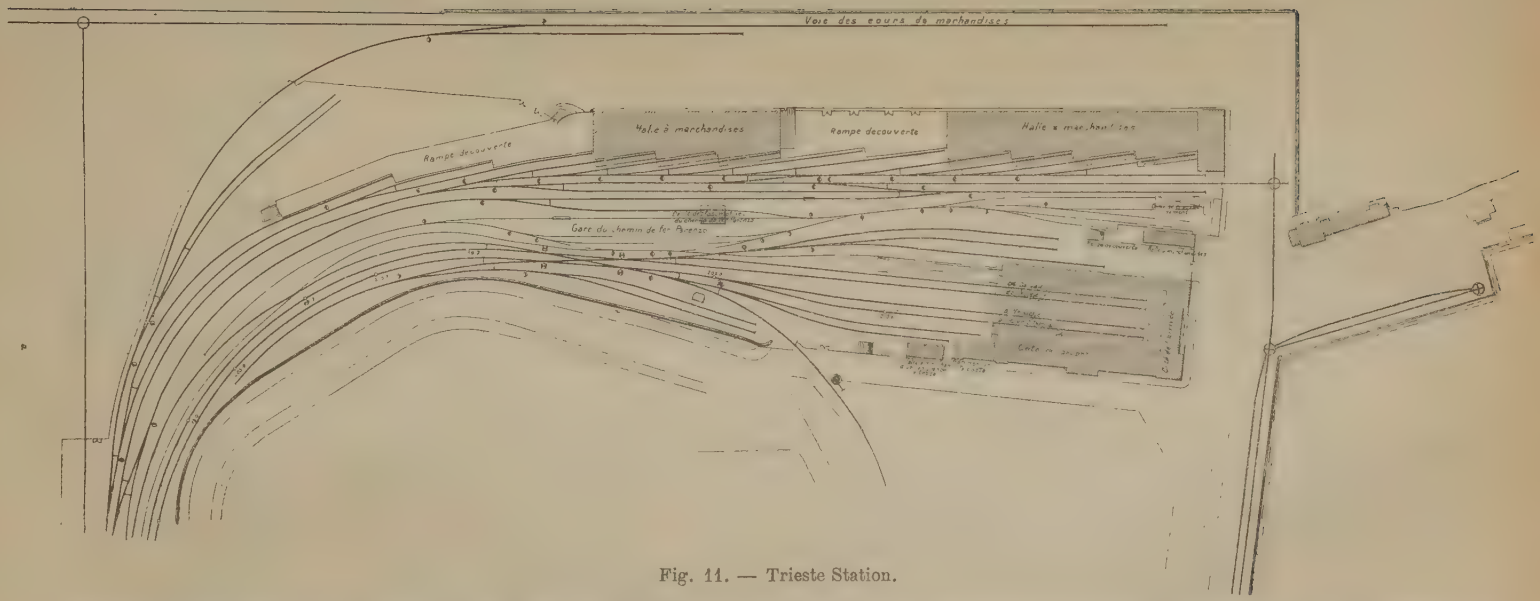


Fig. 11. — Trieste Station.

Explanation of French terms : Rampe découverte = Open Ramp. — Halle à marchandises = Goods shed. — Voie des cours de marchandises = Loading sidings. — Quai de transbordement = Transhipping platform. — Dépôt des locomotives du chemin de fer Parenzo = Locomotive shed of Parenzo line. - Gare du chemin de fer Parenzo = Station of Parenzo line. — Halle à marchandises en grande vitesse = Quick-freight sheds. — Bâtiment de la poste. = Post-office building. — Côté du départ = Departure side. — Côté de l'arrivée = Arrival side.

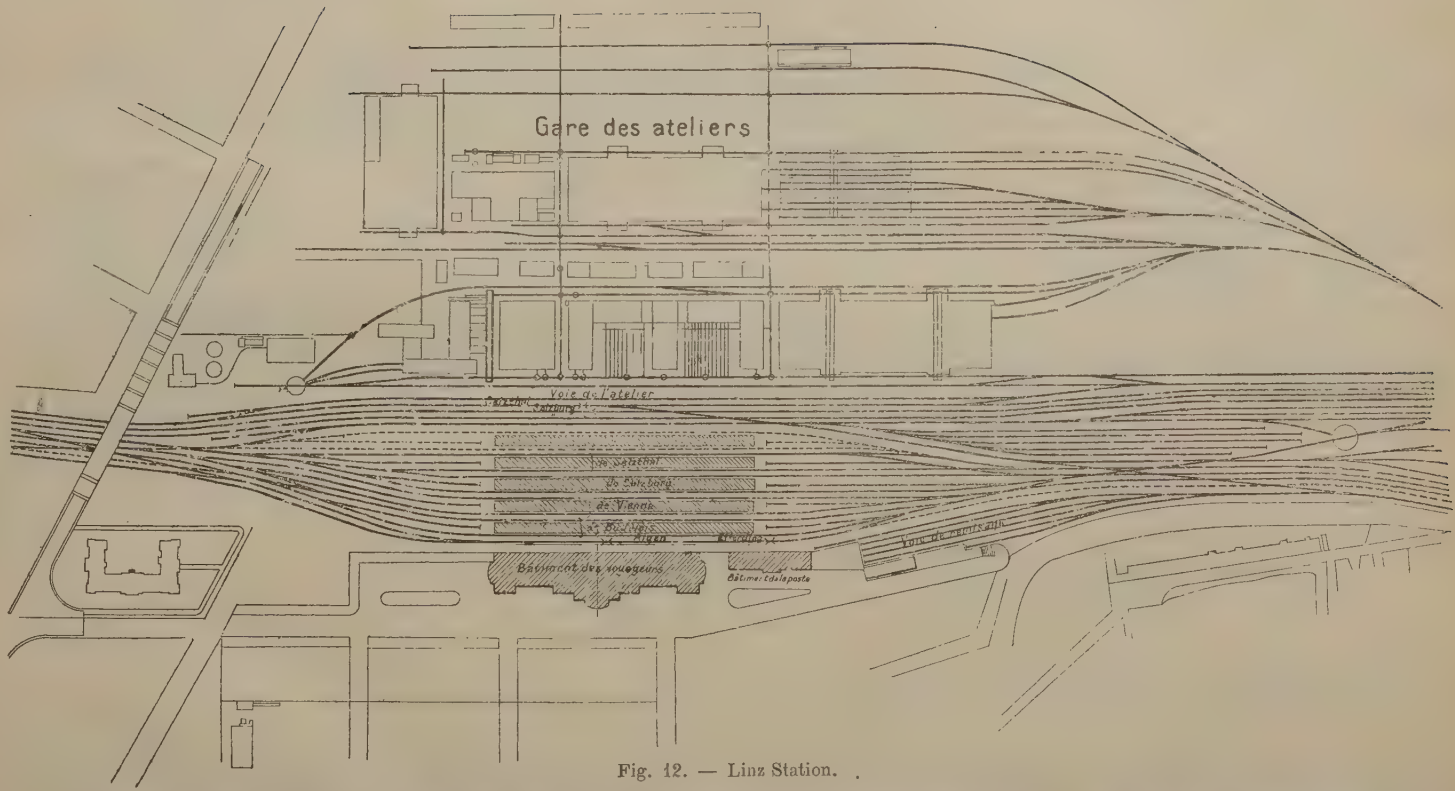


Fig. 12. — Linz Station.

Explanation of French terms : Gare des ateliers = Workshop depot. — Bâtiment des voyageurs = Passenger-station building. — Voie de l'atelier = Workshop sidings. Bâtiment de la poste = Post office building. — Voie de remisage = Train sidings.

kept clear, without interfering with the main lines. It is consequently very desirable to have the locomotive sheds as near to the passenger station as possible.

In order to be able to add or take off individual carriages, dead-ended sidings are provided at the newer stations between the platform tracks; the spare carriages stand on these sidings ready for use. These sidings make it possible to add or take off single carriages in a very short time, without increasing the normal time the train stops and without interfering with the arrival or departure of other trains.

III. — At most of the large stations which we are considering here, even in those cases where larger alterations were made, no provision could in many cases be made for facilitating the making- up of trains on the platform tracks, either because no room was available, or because other difficulties were in the way. The installations made consequently varied with the local conditions.

At those stations where passenger trains are made up or taken apart, one had in most cases to be satisfied, when enough land was still obtainable, to provide sufficient sidings for storing and shunting the trains. These sidings must be connected with the tracks used for the mail and quick-freight operations and with the locomotive sidings..

At the older stations, particularly if they are terminal stations, when trains are made up or taken apart it is often necessary to cross the main arrival and departure lines; this endangers the safety of the working and much reduces the working capacity of the stations.

This disadvantage could be overcome by having the sorting tracks raised or lowered where they cross the other tracks; but in many cases, for instance at the Vienna and the Budapest stations, this can not be done as sufficient length is not available.

In order to prevent this crossing of the main lines it is then necessary, as for instance at the Budapest East and West stations till the new stations are built, to increase the number of the sidings for making up and shunting the trains, both on the departure and on the arrival side.

Particular attention has to be drawn to the advisability of having sidings also on the arrival side, to which the trains can readily be taken without crossing the main lines. The moving of the trains to the departure side, during which it is impossible to avoid crossing the main arrival and departure lines, must be effected at times when trains neither arrive nor depart, and when consequently the main lines are free. The sorting operations in connexion with the trains are in most cases carried out on the departure side.

At terminal stations with much traffic, the only complete solutions is however the construction of sorting stations, designed for the purpose, which should be as near to the passenger station proper as possible and should be located between the main lines, so that when the trains are dispatched or received the main lines are not crossed.

The last condition was fully taken into consideration in designing the new arrangements at Budapest (fig. 10). The sorting and shunting sidings are to be placed near the auxiliary station, also the locomotive sheds for the passenger trains, and the installations for mails and quick

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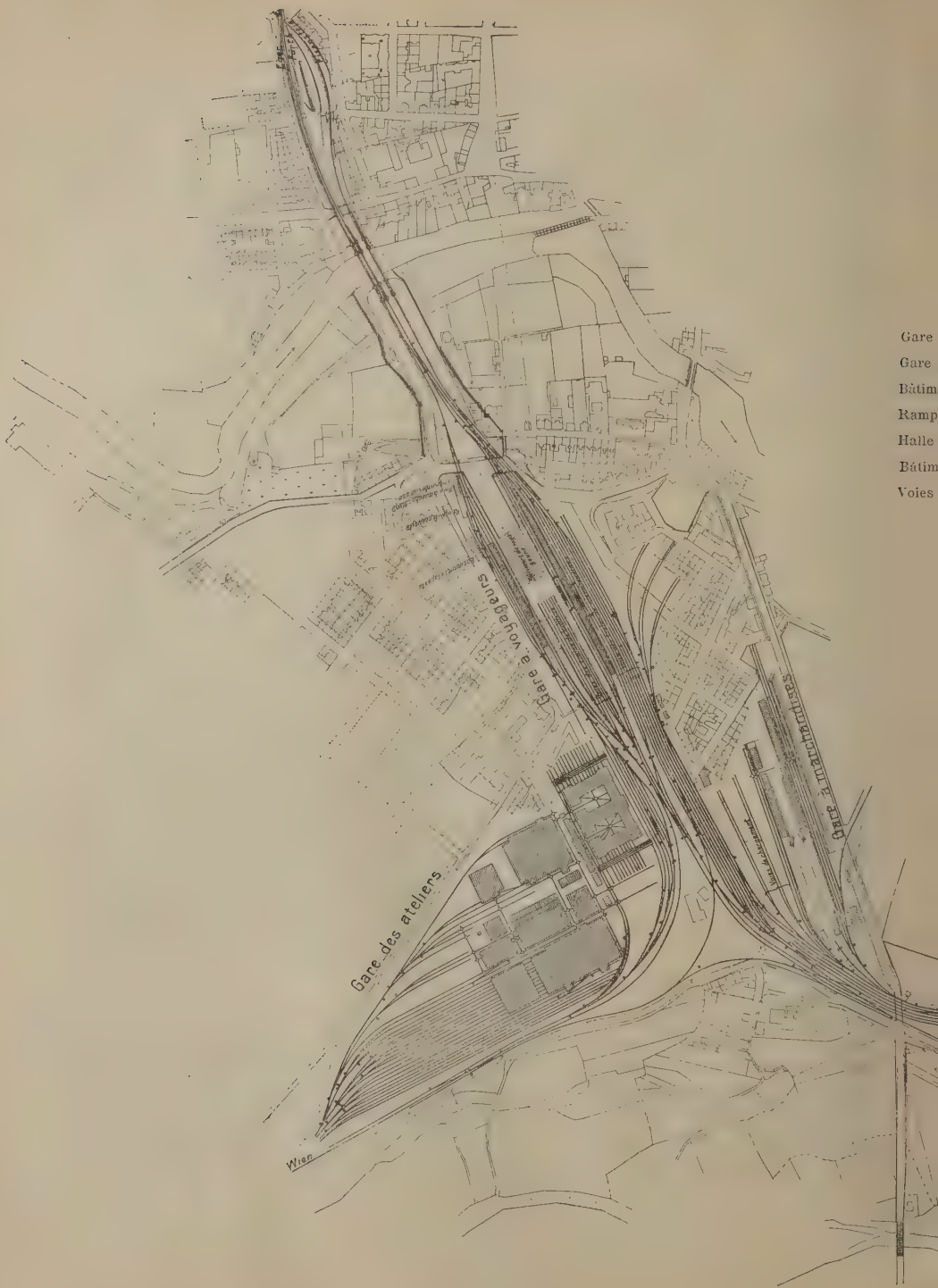
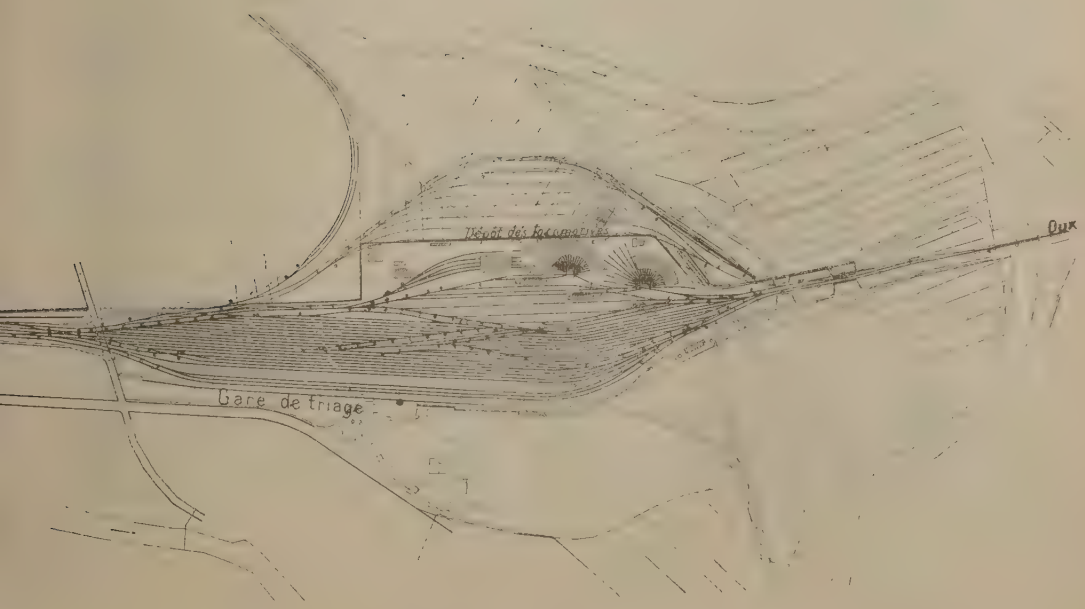

Gare
Gare
Bâtim
Ramp
Halle
Bâtim
Voies
Gare à voyageurs
Gare à marchandises
Gare des ateliers
Wien

Fig. 13. — Pilsen station.

Explanation of French terms :

. . . . . = Workshop depot.
. . . . . = Passenger station.
. . . . . = Post-office building.
. . . . . = Open ramp.
nde vitesse . . = Quick-freight shed.
. . . . . = Passenger-station building.
. . . . . = Sidings for suburban train.

Voies des trains de voyageurs . . . . . = Sidings for passenger trains
Voies de chargement . . . . . = Loading sidings.
Gare à marchandises . . . . . = Goods station.
Wien . . . . . = Vienna.
Gare de triage . . . . . = Sorting and shunting yard.
Dépôt des locomotives . . . . . = Locomotive shed.



freight. The loops will reduce shunting operations to a minimum, because both the long-distance trains and the short-distance trains are generally definitely made-up trains.

Special readily-accessible sets of sidings or only single sidings, as may be required, are provided for taking the mail, parcel and luggage vans, the saloon carriages and the sleeping and dining cars; the locomotive sheds, which are to be exclusively for the passenger traffic, are to be in the middle of the whole installation, so that the distances the locomotives have to cover may be reduced to a minimum.

As already mentioned, such stations are to be constructed on the two opposite sides of the Budapest town limits. As a rule, all the passenger trains coming from the north, after passing the three through stations, will be taken apart and turned round at the south auxiliary station or the sorting station connected with it. In addition the tracks are designed so that international or other through trains, after their locomotives have been changed with as little delay as possible, can continue in any direction; all these arrangements will probably make it possible to receive and dispatch about four times as many trains as at present inside the twelve hours within which the greatest part of the Budapest passenger traffic is operated, which at present amounts to nearly 300 trains per day.

It must also be mentioned, in connection with this question, that various measures have also been adopted in the other countries with which this report deals, in order to accelerate the operation of the traffic at the old passenger stations, which are taxed to the limits of their capacity; particularly with a view to reducing the time necessary for marshalling the passenger trains.

Among them we may mention the system adopted in a number of cases, of sending the mail vans and the cars containing quick freight (beer, fruit, live and dead poultry, meat, fresh vegetables, race horses, etc.), which are to be hauled by passenger trains, as quick-freight trains in advance to some junction station, where they are then coupled up to the passenger train during its normal stop.

Question 1-*d*. — *Have you any stations with separate floors, in which the tracks are, either all or in part, either on an upper floor or in a basement, the ground floor being used for different offices (enquiry offices, booking offices, luggage offices, etc.)? In the case of a mixed arrangement, that is to say, when some of the tracks only are at another level than the ground floor, which tracks are at that level and which are on the ground floor? In the case of stations with separate floors, how are the different services distributed between the ground floor and the other floor? What circumstances: topographic location, difficulty of widening, etc., have led to the adoption of separate floors? What advantages do you consider this arrangement to have to make up for the increased amount which as a rule such a station costs to build and run?*

Stations with different floors, such as at Boston or Dresden-Altstadt, where the tracks are on different floors, do not exist on the railways of the countries with which our report deals. No scheme of this kind has ever been seriously entertained. There are even no cases in which some tracks are at street-level, while others

are raised or sunk. There are comparatively few stations at which the tracks are a floor up. The stations hitherto built, together with their sorting stations and the locomotive sheds are at the level of the ground.

Stations with separate floors, in which all the tracks are in a basement, as for instance at the new Hamburg station, also do not exist in the countries with which this report deals.

In the case of the two through stations which it is proposed to build at Budapest inside the city, the tracks at the one are to be above street-level, and at the other below street-level, in accordance with the local conditions.

At the stations hitherto built which are a floor up, all the tracks used in connection with the passenger traffic are on the same floor. Such stations are : In Austria, the Vienna North and the Vienna South stations; also the stations at Lemberg (fig. 4), Pilsen (fig. 13), Budweis and elsewhere; in Hungary, Szeged station (figs. 22 to 25) is an instance. As far as we know, no such stations yet exist in the other countries with which our report deals.

At these stations, the entrance hall and the booking office are as a rule on the ground floor, as well as all the luggage offices and the newspaper and tobacco stalls, etc. The installations for the post-office, the station offices and the exit lobby are also on this floor. The waiting rooms and refreshment rooms are on the first floor, as well as the traffic offices. The arrangements at the Vienna North and Vienna South stations are very similar. At the North station some of the station offices are on the ground floor and some on the first floor.

At Pilsen (fig. 13) the station building is in the middle between the high-level tracks, and the entrance to the station is reached by crossing under them. The capacious entrance hall is on the ground floor, together with the ticket offices and the luggage offices, while the waiting rooms, refreshment rooms and the station offices are at track-level. The middle platform is used for the Vienna-Eger and the Prague-Fürth trains. The island platforms for the other trains and the loops are reached by means of stairs and subways. The tracks for the short-distance trains, for which the station forms a terminal station, are accessible from the front of the station building (1).

At Budweis station the large entrance hall is reached from the front of the station, with the waiting rooms and refreshment rooms adjoining. The three high-level island platforms are reached by a subway and a staircase, along the centre line of the building. On arrival another subway and staircase lead to the exit lobby. The ticket offices and the luggage offices are also in the large entrance hall; the station offices are at track-level.

At Lemberg (fig. 4) several steps lead up from the street to the entrance lobby, in which space is provided for the mail and the newspaper traffic. This lobby leads to the capacious entrance hall, where the ticket offices and the luggage offices are; from this wide corridors lead to the right and left to the waiting and the refreshment rooms.

(1) See the pamphlet *Oberbau, Bahnhofsanlagen und Eisenbahnhochbau*, by Hugo Koestler, privy councillor to the Railway Ministry, from which some of the particulars concerning Austrian railways have been extracted.

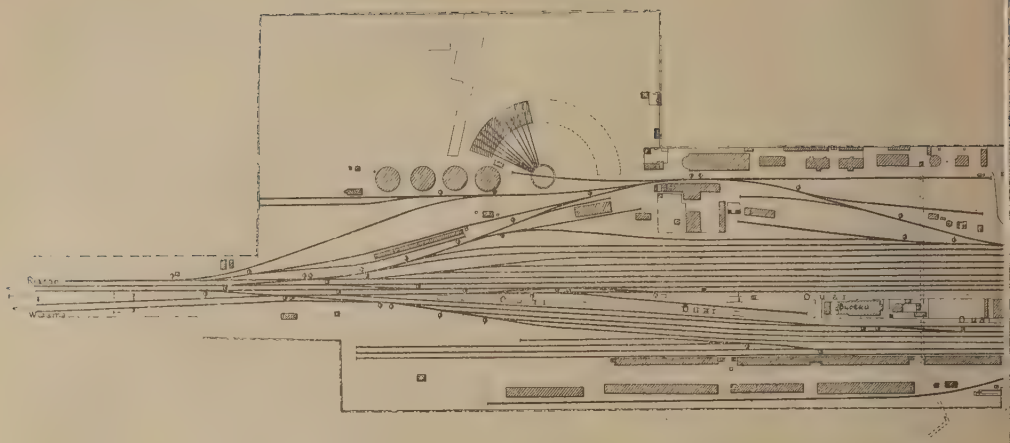
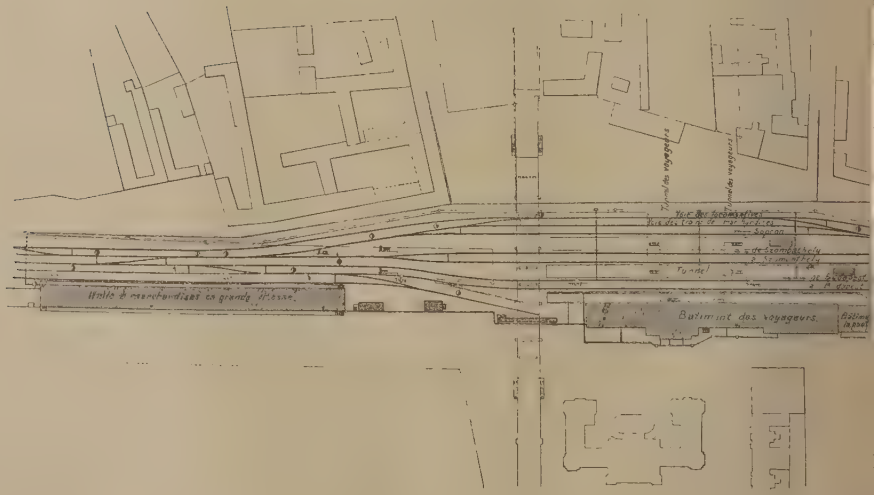


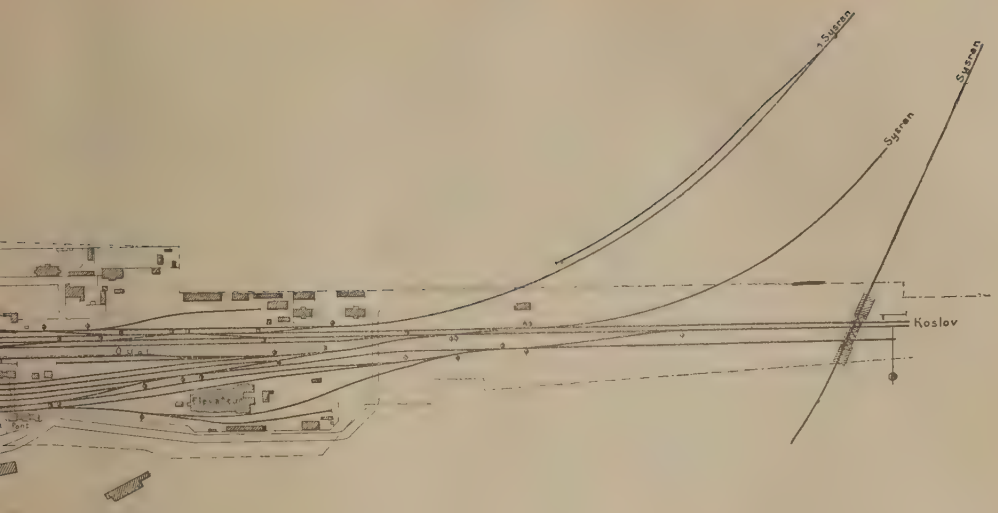
Fig.

Explanation of French terms : Quai = Platform. —



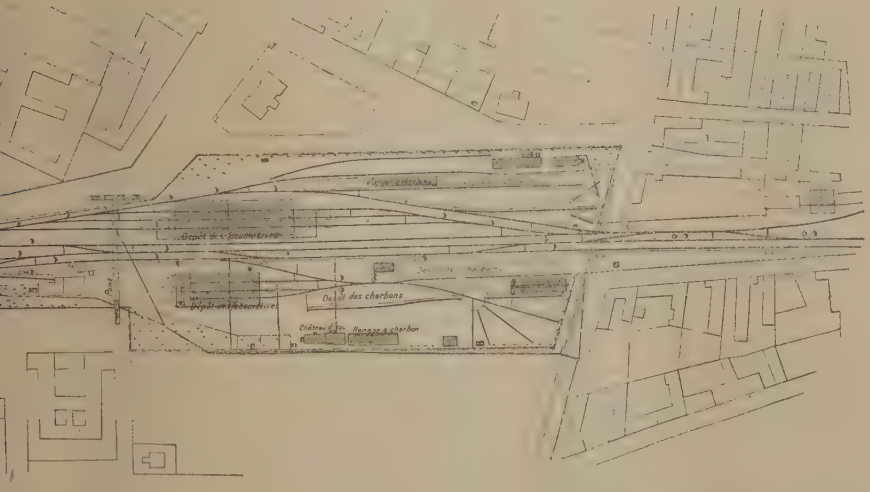
Fig

Explanation of French terms : Pont = Bridge. — Bâtiment des voyageurs = Passenger-station building. — Ha
Tunnel des voyageurs = Passenger subway. — Voie des locomotives = Locomotive siding. — Voie des tr
= Water-tower. — Hangar à charbons = Coal shed. — Dépôt des charbons = Coal yard. — de = from. —



n.

Bâtiment = Building. — Élévateur = Elevator.



tion.

en grande vitesse = Quick-freight shed. — Bâtiment de la poste = Post-office buildipg. — Tunnel = Subway. —
s = Lines for goods trains. — Dépôt des locomotives = Locomotive shed. — Bureau = Office. — Château d'eau

Seven subways lead from the ground floor to the platforms. Three of these subways, with two staircases each and separate entrance and exit, are provided for passengers of the first, second and third class respectively. Arriving luggage, departing luggage, mails and quick freight each have one subway provided for them. To the right of the entrance hall is the exit lobby, where the exit subway and the subway for the arriving luggage end. In the left wing of the first floor there are private waiting rooms for the Royal family, with a private entrance and a private staircase from the street. In the right wing, at track level, there are the station offices and staff offices. A special building, directly accessible from the platforms, is provided for dealing with the mails.

At the Szeged high-level station (figs. 22 to 25) subways are not yet in use. The entrance hall is at street-level, and from its right and its left convenient staircases lead up to the tracks; it contains the ticket offices, the luggage offices, the newspaper offices and the police office. The way out is through a special lobby with special staircases leading down to the street. On the first floor, that is at track-level, there are the waiting and the refreshment rooms, the traffic and the other service offices. Here are also the offices for the mails and for the quick freight, which are made accessible from the street by ramps.

The reasons which lead to the construction of high-level stations, vary according to local conditions. But generally speaking it can already now be recognized that it is not advisable to build stations at street-level inside towns of larger or of medium size, if these towns are capable of further development; it is better to build the stations below or above the street-level.

This is very advisable in the interests of the public traffic and of the municipal administration, no matter whether it is a question of a through station or of a terminal station; for only if this condition is observed can a station be located in the middle of a town or very near it.

When matters are so arranged the streets can pass either above or below railway track, and both the street traffic and the railway traffic can be operated without interfering with the other.

On the other hand if the stations are at street-level, the wide railed-in spaces they occupy practically cut the town in two and not only obstruct the street traffic but impede the development of the whole town.

It is true that level-crossings, which would obstruct the traffic at large stations, can be done away with by putting in underbridges or overbridges; but when the stations are at street level the necessary approach ramps are a disadvantage both to the street and to the traffic.

Besides these general reasons, which are probably of preponderating influence in the case of any large town, special local conditions have in most cases affected the choice made.

In order to indicate a few of these, we will as an instance describe how some of these stations became developed.

The city of *Pilsen* is one of the large industrial and commercial centres of Bohemia, at which many railway lines intersect. These lines were built at different periods and by different owners. The station of the first railway, the Prag-Fürth

line, the so-called "West" station, was built in 1862; while the Vienna-Eger and the Pilsen-Priesen lines were built in 1868-1876. The West station and the separate station built for the Pilsen-Priesen line, were it is true extended as much as possible to suit the growing traffic; nevertheless in 1895, when all these three railways were incorporated in the State Railway system, the stations no longer sufficed for their work. As however both stations had in course of time become surrounded by large factories and other valuable buildings, it would have been excessively expensive to enlarge them. In order to meet the growing industrial requirements, the whole railway installations were rearranged. The two old altered stations were replaced by a large new passenger station (fig. 13); the old workshops of the Pilsen-Priesen line were replaced by a large new goods yard. The two workshops as well as the sorting stations were located outside the city. The lines going to the station, which cross parts of the town where there is much traffic, as well as the passenger station itself, were all built at a high level.

Budweis station was a joint passenger station used by two privately-owned main lines, Vienna-Eger and Linz-Budweis, while the goods traffic was dealt with at two separate stations. After these lines had been incorporated in the State system, the great increase in the traffic which had in the meantime taken place made the complete reconstruction of the stations necessary. The passenger station and the tracks entering it were raised 6 metres (19 ft. 8 in.), in order to allow the busy streets to pass below them. On the other hand, the goods and sorting stations were left at street-level, in order to lay out the line more favourably, but in doing this, level crossings were avoided.

At *Lemberg* the Karl-Ludwigs Railway and the Lemberg-Czernowitz-Jassy Railway each had a separate station built in their time. After the two lines were incorporated in the State system, the first station was converted into a passenger station and the second into a goods station.

Later on these stations were enlarged, but as the traffic grew they no longer sufficed; they were accordingly entirely rebuilt by the administration of the Austrian State Railway. Of the old installations only the goods station remained, while a new station, connected with a corresponding sorting station, was built for the passenger traffic.

The passenger station was raised over a length of 1,000 metres (1,094 yards) above the level of the other stations, chiefly in order to make it possible for the lines which connect the other stations to pass under the passenger stations. Another object of this arrangement is to give the passengers readier access to the different platforms (fig. 4), as already mentioned.

The station at the city of *Szeged*, which is the second largest city in Hungary as regards population, also had to be constructed at a high level, principally on account of the Tisza bridge, which is in its immediate neighbourhood and is at a considerably higher level than the streets of the town. This arrangement makes it easy for the streets and roads to pass under the railway.

In the case of the proposed reconstruction of the Budapest stations, the interests

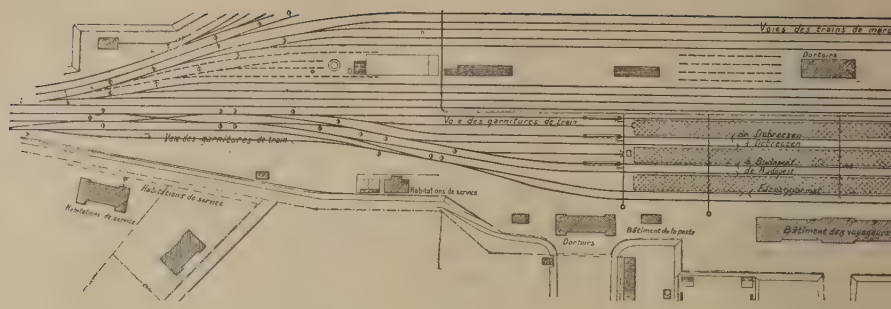


Fig. 1

Explanation of French terms : Voie des garnitures de train = Siding for made-up trains. — Habitations de service =
= Lines for goods trains. — Trains des bestiaux = Cattle trains. — Rampe découverte = Open r

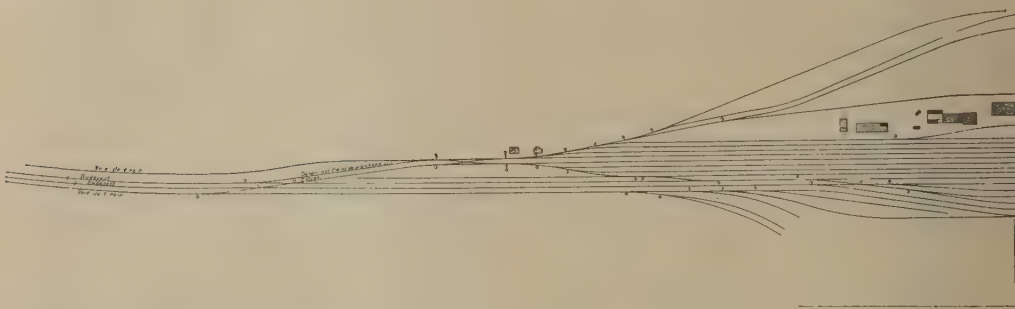


Fig.

Explanation of French terms : Départ des trains de marchandises = Departure of goods trains. — Entrées des trains de ma
= Locomotive sidings. — Voie de tiroir = Draw-out track. — Voie de réparation des véhicules = Siding for repairing ca

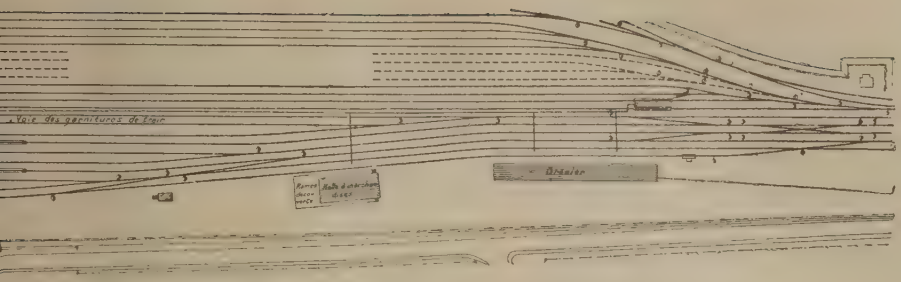
of the city traffic and of the municipal administration in the first place led to the selection of a high-level track, and to that of a low-level where geographical and other conditions made this necessary.

QUESTION 1-*c*. — *Have you adopted the solution of "double platforms", applied more especially at stations on the French Northern Railway ?*

Such "double platforms" are hardly in use in the countries with which our report deals.

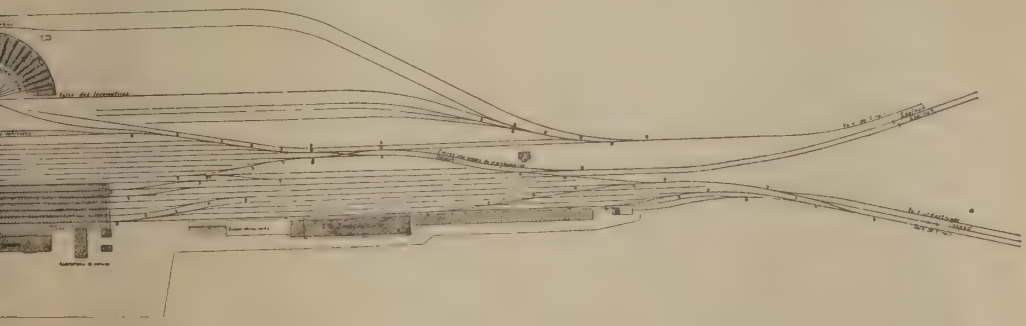
At Riaj station (fig. 14) on the Riazan-Viazma Railway (Russia), there is a kind of double platform, but not arranged as at St. Omer and other stations on the French Northern Railway.

The arrangement at Riaj station is shown in figure 14; each of the two sides of the double platform is used simultaneously for receiving two trains coming



station.

irs = Sleeping quarters. — Bâtiment des voyageurs = Passenger-station building. — Voies des trains de marchandises
handises = Goods shed. — Grenier = Grain-store. — Bâtiment de la poste = Post-office building.



tion.

of goods trains. — Rampe à charbon = Coal ramp. — Dépôt des locomotives = Locomotive shed. — Voies des locomotives
handises = Goods sidings. — Halle à marchandises = Goods shed. — Voie industrielle = Works line. — de = from — à = to.

from different directions. Thus for instance on track I a main-line train can arrive from Riazan, while at the same time another arrives on track V from Viazma. At the same time, on the other side of the platform, a main-line train can arrive from Koslow on track II and another on track III from Syzran.

Question 2. — *Please describe the mechanical appliances you have, either at the stations with separate floors, or at the stations at one level: a) For the conveyance of luggage (lifts, motor tricycles, travelling endless belts, etc.); b) For the conveyance of passengers (lifts, travelling inclines, moving staircases, etc.); c) To your answer please add particulars and drawings of the appliances mentioned under a) and b).*

In the case of stations at street-level, in the countries with which our report deals, mechanical appliances have not hitherto been used for the purposes mentioned. As a rule hand-carts with three or four

wheels are used for conveying luggage from the luggage offices to the luggage vans of the trains.

In the case of some of the high-level stations the luggage is raised from the luggage office in the ground floor to track level and vice versa by means of electric lifts. The hands-carts which are loaded with the luggage are placed into the cage, lifted and then run to the luggage van; or conveyed in the same way in the opposite direction to the luggage-delivery office. Such a lift is in use at Szeged station; it is however not located in the entrance hall but at the chief platform between the station building and the first track.

A special installation of this kind exists at Wilna station (fig. 21) on the Russian North Western Railway, where the tracks are at street level; between them there are island platforms, which are connected with each other by a subway. The hand-carts loaded with luggage are lowered to the level of the subway, and then pushed to the lift of the platform required and there raised. Arriving luggage is dealt with in the opposite way. Motor tricycles, travelling endless belts and mechanical devices other than those mentioned have hitherto not been used for the conveyance of luggage.

Neither lifts nor travelling inclines nor moving staircases are used for the conveyance of passengers.

At the through stations which are at street-level the trains are generally reached from the waiting and refreshment rooms by crossing the lines, and the exit lobbies are reached from the trains in the same way. Passengers are only allowed to cross the lines at certain paved crossing places. At busier stations, low wire-fences are put up between the tracks, except at the crossing places, so as to compel the public to keep to the latter.

At larger stations which are at street-level, island platforms are provided, as the large number of trains makes crossing the lines dangerous.

In most cases, the main platform is next to the station building, and from it a staircase leads down to a subway, which crosses below the rails and is connected with the different island platforms also by staircases.

In the case of terminal stations at street-level, the passengers reach the intermediate platforms directly from the end cross platform. In the case of terminal stations where there is no end cross platform, subways and stairs are used.

At some of the older high-level stations, for instance Vienna North, Szeged, etc., there are as yet no subways, and the island platforms can only be reached by crossing the line.

At Budapest West station, there is a subway near the hall which has a special object. It connects the quick-freight receiving and dispatching offices, which are at the two opposite sides of the building. Its chief object is to be able to transfer arriving transit quick-freight to the departure side; it also has the object of facilitating the transfer of some mail matter, particularly newspapers and articles of value, from the post-office which is at the side of the station to the mail vans which are already attached to trains about to depart. Finally, the subway is also used for taking the electric accumulators used for train lighting from the charging house to the platforms and vice versa. The subway is 4 metres (13 ft.

1 $^{1}/_{2}$ in.) wide and 2·5 metres (8 ft. 2 $^{7}/_{16}$ in.) high, and has several lateral branches which lead to the points where quick-freight is dispatched and received, where accumulators are charged and where the mails are dealt with. The tunnel and its branches are connected with the different places by a number of electric lifts.

B. — Large goods yards

Question 1. — *Are the sidings at some of your sorting and shunting yards arranged so as to ensure the continuity of the movement, in one given direction and consequently without any reversal, of the cars to be dealt with, from the time an arriving train is received until a train is made up and ready to leave?*

Question 1-*a*. — *Are these sidings on a continuous incline so that the cars can be sorted by gravity without requiring a locomotive, or do they consist of successive sets of sidings on the flat, commanded by saddle-backs on to which the trains are pushed by the locomotive? Are there successive gridirons which allow a train to be classified according to destination and on which the making up of a train can be completed?*

1. — The sorting and shunting yards of the railways with which our report deals, were constructed in their time according to many different plans and have been extended and altered in many different ways since.

Sorting and shunting yards, which are arranged so as to ensure the continuity of the movement of the cars, from the time of their arrival at the yard until they are made up into trains ready to leave, without the wagons having to make any unnecessary movement, are only of quite recent introduction in the countries which we are considering. The construction of such yards, which make very economic working possible, would in most cases require a very large capital expenditure, which it is true would in course of time be counterbalanced by the advantages obtained; but the capital required is not always available.

In those cases in which the sorting is to be not only according to direction but also according to station, care would have to be taken that the arriving trains can at once pass from the reception sidings on to the sorting sidings following the reception sidings; the cars are then to pass on to the gridiron and then on to the departure sidings, all these sidings being arranged longitudinally so as to form continuations of each other, so that the ready train can then at once start from the departure sidings.

But even with this arrangement, which might be considered perfect, the superfluous movements of the cars, while they arrive and are sorted and leave again, can only then be wholly avoided if the yard is divided into two separate halves, quite independent of each other and each used for one chief direction.

The arrangement would accordingly have to be such, that for instance in order to sort the goods trains coming from the north and going to the south there would be one special separate sorting yard, consisting of the four sets of sidings described above; and for the goods trains coming from the south and going to the north there would be another similar yard with

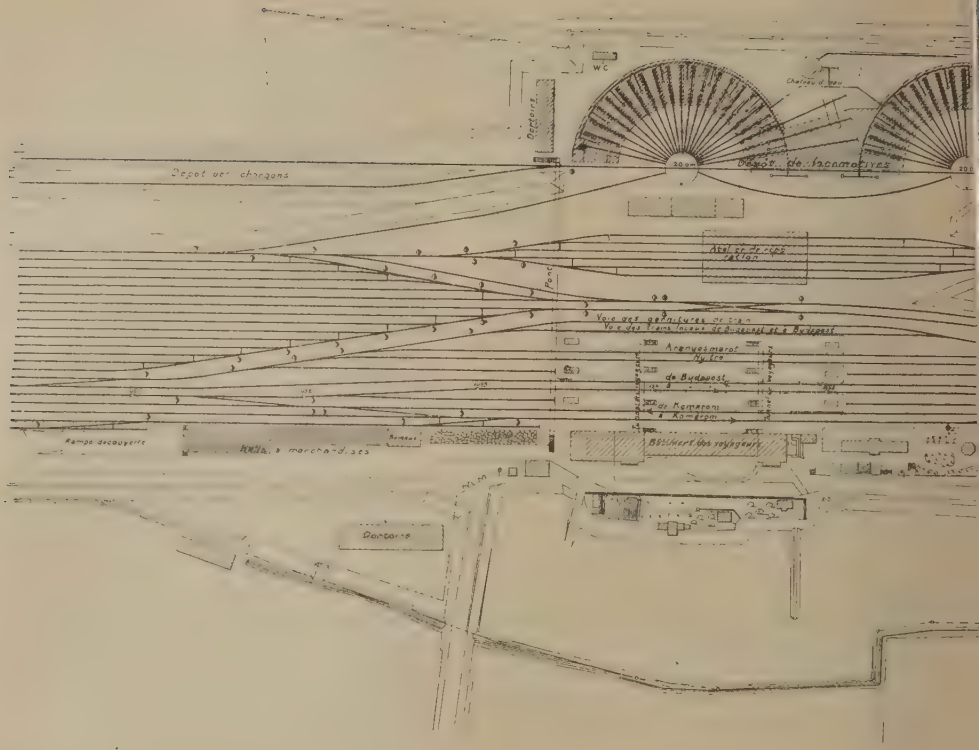


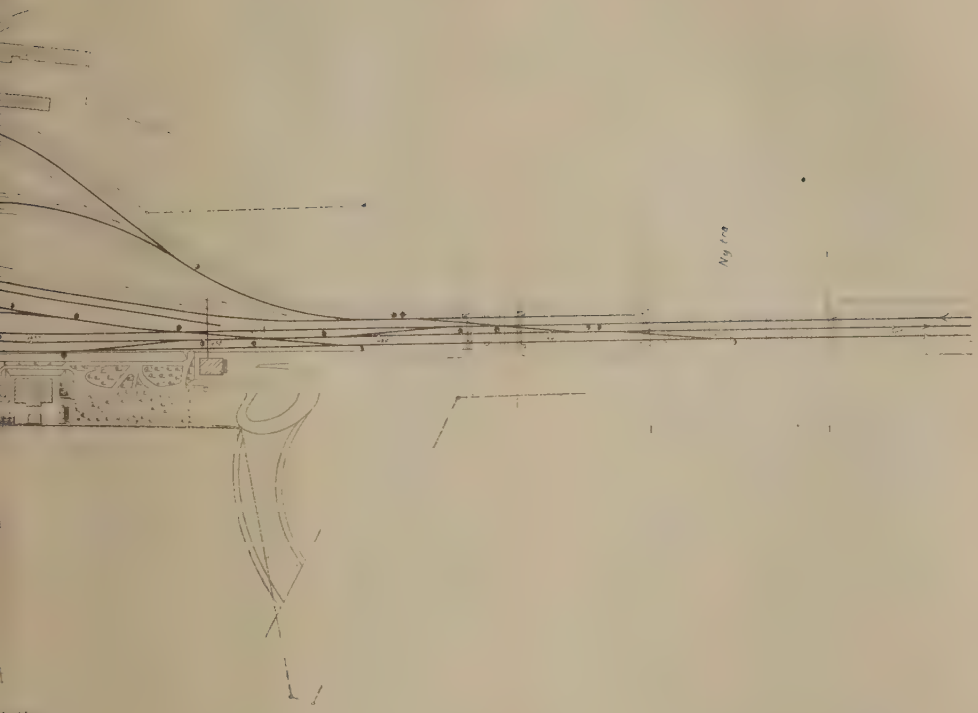
Fig. 1

Explanation of French terms : Dépôt des charbons = Coal yard. — Rampe découverte = Open ramp. — Halle à m
motives = Locomotive shed. — Atelier de réparations = Repair workshops. — Pont = Bridge. — Voie des garn
Budapest. — Bâtiment des voyageurs = Passenger-station building. — Passage en dessous. = Subway. — de =

the sidings arranged in the reverse direction.

Such sorting and shunting yards may with full justice be described as perfect; but as far as we know there are only a few on the whole continent of Europe and these have only been built very recently. The high cost of construction, the great technical difficulties which have often to be overcome when building such yards several kilometres in length, if the country is at all undulating, in order to cross highroads and watercourses, are generally great obstacles to the construction of such extensive installations. In large cities, these difficulties are still further increased by the great cost of the land, quite apart from the fact that the large empty spaces required are as a rule only to be found at greater distances from cities.

These are no doubt the reasons why up to the present very few such sorting and



tation.

s shed. — Bureaux = Offices. — Dortoirs = Sleeping quarters. — Château d'eau = Water-tower. — Dépôt de loco-
ing for made up trains. — Voie des trains locaux de Budapest et à Budapest = Track for the local trains to and from

shunting yards have been constructed. Moreover, it is not advisable, unless there is very much traffic, to expend the large sums of money which such large installations involve, and even at the most important junction points in the countries with which our report deals, the need for such installations does not everywhere exist. At some otherwise important junctions, operations can still be carried out sufficiently economically by simpler even if imperfect installations. As a general rule however the administrations have endeavoured to arrange the larger sorting and shunting yards which they have built in recent times, or are going to build, in such a way that loss of time and unnecessary movement of the cars are avoided as much as is possible under the existing local conditions, and considering the needs of the traffic.

1-*a*. — In the countries with which our

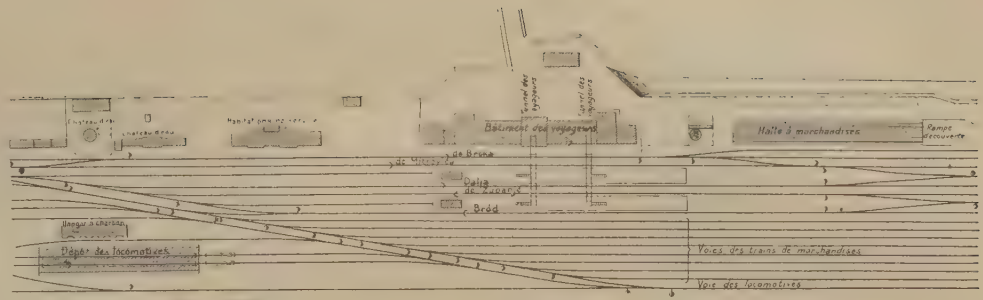


Fig. 19. — Vinkovce station.

Explanation of French terms Château d'eau = Water-tower. — Habitations de service = Staff quarters. — Hangar à charbon = Coal shed. — Dépôt des locomotives = Locomotive shed. — Bâtiment des voyageurs = Passenger-station building. — Tunnel des voyageurs = Passenger subway. — Halle à marchandises = Goods shed. — Rampe découverte = Open ramp. — Voie des trains de marchandises = Lines for goods trains. — Voie des locomotives = Locomotive siding.

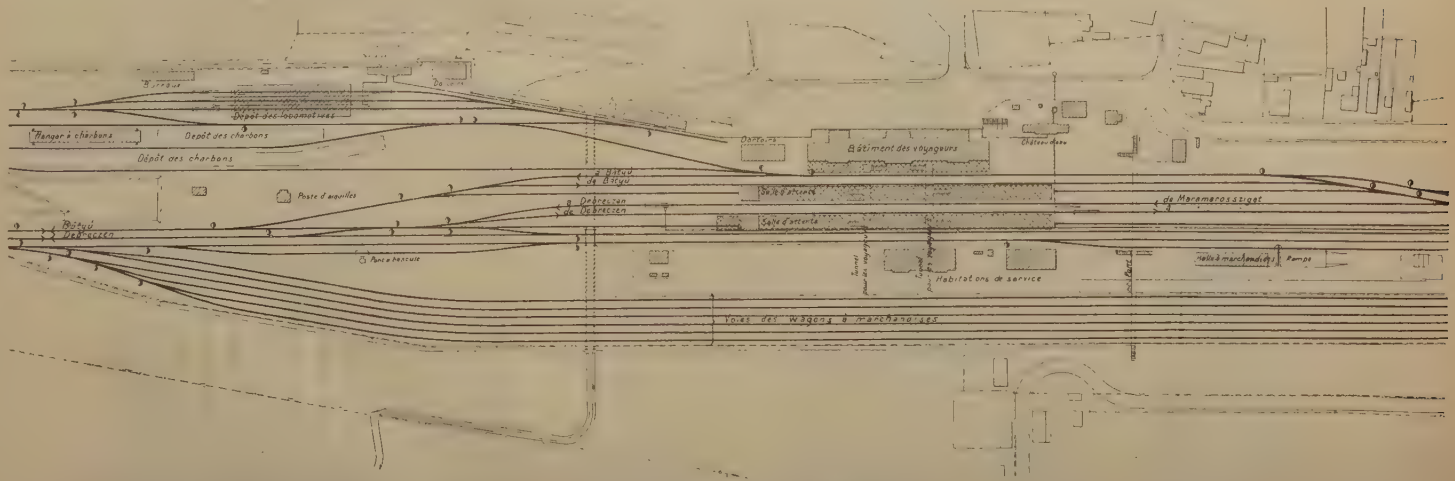


Fig. 20. — Királyháza station.

Explanation of French terms: Bureaux = Offices. — Dépôt des charbons = Coal yard. — Pont à bascule = Weighbridge. — Poste d'aiguilles = Switching point. — Dortoirs = Sleeping quarters. — Salle d'attende = Waiting room. — Voies des wagons à marchandises = Lines for goods wagons. — Pont = Bridge. — Rampe. = Ramp. — de = from. — à = to.

report deals, no single sorting and shunting yard has yet been constructed, which is wholly on a continuous incline, so that the cars of the arriving train could be sorted, without using locomotives, and arranged in trains on the departure sidings.

Most of the older sorting and shunting yards were constructed in their time on the flat or nearly so, so that the shunting operations are carried out by locomotive power. The trains arrive on the sidings which serve both for reception and for departure sidings, the locomotive and the brake van are removed; the cars are then sorted and shunted on to the corresponding siding of the sorting-siding group by a shunting locomotive. The cars collected on each sorting siding, if no further sorting is required, are then shunted on to the departure sidings and the train is then made ready for starting by coupling on the locomotive and the brake van.

At those sorting and shunting yards where the main line can be directly reached from the sorting sidings, the train often starts from the sorting siding.

If it is also necessary to sort according to station, this is as a rule effected at the other end of the sorting sidings.

This system of sorting according to station is not economic, as two locomotives are required, and many operations. The process is tedious and the cars can not be properly utilized and dispatched quickly enough, as two locomotives can only shunt 500 to 700 cars in twenty-four hours.

At the Rákos-Rendezö sorting and-shunting station, which deals with the traffic of the goods station of the Budapest West station, and where about 2,700 cars arrive per day, the sorting sidings are divided into four groups, and it is consequently possible to carry out several sets of shunting operations simultaneously. Seven or eight locomotives are used for this purpose.

The same state of affairs also exists at many of the older Austrian and Russian sorting and shunting yards; for instance in Austria at Stadlau, Trübau, Floridsdorf, etc., and in Hungary at Ersekujvár, Györ, Komárom, Szeged, Nagyvárad, Kassa, Zsolna, Kuttka, Püspökládany, Czegléd, etc. Another great disadvantage of this method, besides those already mentioned, is that it is impossible to remove the row of cars which require sorting, from the reception sidings and take them to the inclines, if in the meantime trains are arriving or departing. Finally reasons of safety make it in most cases inadvisable to do sorting by stations at the opposite end while sorting by direction is going on at one end.

In order to make it possible to carry out both these sorting operations simultaneously, the sorting sidings would have to be made much longer than required for the longest trains dealt with. This would however in most cases materially increase the cost of construction.

In order to make it unnecessary to interfere with the joint reception and departure sidings during shunting operations, draw-out sidings were provided at both ends of many such sorting and shunting yards. The greater number of the modern and more suitable sorting and shunting yards which at present exist, became developed in course of time out of this original form.

When in consequence of the growth of

*

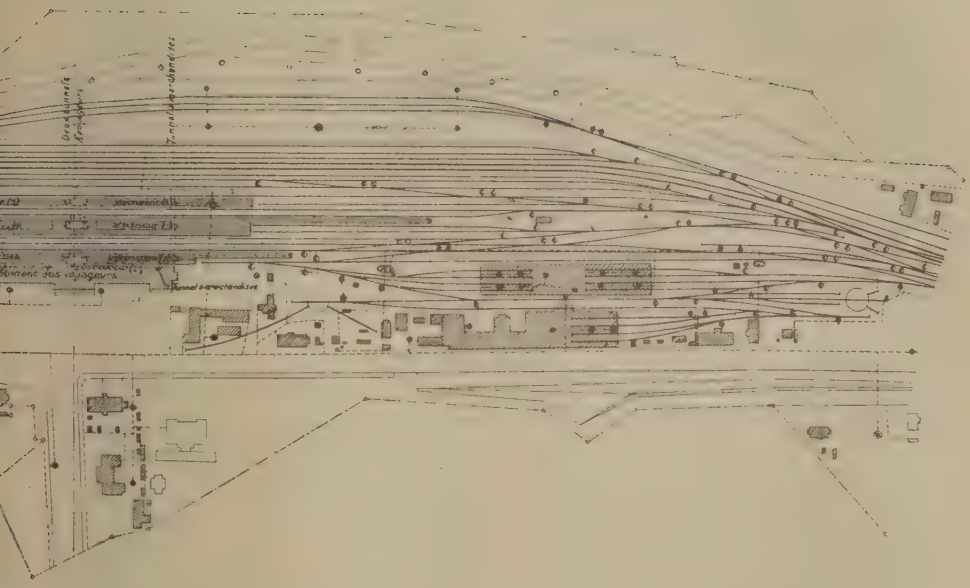
Fig

Explanation of French terms : Bureaux = Offices. – Tunnel à marchandises = Subway for goods. – Deux

the goods traffic or of the addition of new railway lines, the sorting and shunting yards, which were arranged on the flat and for locomotive shunting, were no longer able to cope with the traffic, although the number of their sidings had been materially increased, the administrations were compelled to adopt the English systems, and of the two English systems known, they naturally used that which involved least expense in transforming the old sorting and shunting yards.

It would however hardly have been possible to adopt the system of a continuous incline, and to convert the old yards in this way, without long and serious interference with the traffic, for the inclines must have a gradient of about 8 to 10 per mil; if for instance the total length of the yard were 2 kilometres (1 mile 427 yards); then the one end would have to be raised 20 metres (22 yards). If the yard were on the flat or nearly so, this would involve very great expense and all traffic would have to be stopped while the work was being executed.

Consequently, in all cases where the old level yards, intended for locomotive shunting, were to be altered and gravity shunting used, the second English system was adopted, namely that of saddle-backs; the existing sorting sidings can then in greater



tion.

= Two subways for passengers. — Bâtiment des voyageurs = Passenger-station building. — Ascenseur = Lift.

part remain in their original position on the flat, and it was only necessary to raise the draw-out track at the one end of the station to the height of the incline, that is to 1 or 2 metres (1 to 2 yards); the end of the sorting sidings connected with the draw-out track also requires a gradient of 3 to 5 per mil to be given to it.

These alterations can be made without particular difficulty and without material interference with the traffic, and cost comparatively little. But installations modified in this way can only satisfy the requirements of a modern sorting and shunting yard to a limited extent.

The row of cars which is to be sorted is then hauled by a shunting locomotive from the reception sidings to the draw-out track, and the cars are then sent from these down the incline to the different tracks forming the sorting sidings, from which the completed trains as a rule depart direct.

Sorting and shunting operations at such yards are more economic and also somewhat quicker than at yards on the flat; thus for instance the same amount of work requires seven to eight locomotives at Rákos-Rendező yard which at Szolnok, where there is an incline, only requires four or five.

Sorting according to station is also

carried out at most of the stations of this kind in this way. At some shunting stations, there are however on the opposite side of the incline, a number of dead-ended sidings in connection with the draw-out track; these are used for station sorting.

Sorting and shunting yards with inclines arranged in this way are to be found, among others, in Austria at Mährisch-Ostrau-Oderfurth, Aussig, Salzburg, Pilsen, Budweis, etc.; in Hungary at Miskolez, Rákos, Szolnok, Dombóvár, Budapest-Ferenczváros (fig. 26), Pozsony, Hatvan, Piski, etc.

A further development in shunting yards with inclines is to be found, for instance in Austria at Oderberg (fig. 27). Here there is a set of secondary sidings forming a continuation of the sorting sidings, and the sorting sidings are divided into two groups, one serving for the cars which require no further sorting, and are accordingly taken from the sorting sidings to the departure sidings, or else can start from the sorting sidings direct, while the second group is used for the cars which still have to be sorted according to station. These cars are then pushed by the shunting locomotive to the corresponding track of the secondary sidings, from which the trains when ready can start direct, or else can be taken to the departure sidings.

This arrangement corresponds more nearly to the principle according to which the movement of the cars during the sorting and shunting operations should be reduced to a minimum and should always be in the same direction. Among others, the larger sorting and shunting yards of the Austrian State Railway, at Oderberg (fig. 27), Strasshof (fig. 28) and Prerau (fig. 29) and Linz, are arranged in this way.

Their chief advantage, as compared with the yards previously described, is that the arriving train need not first be hauled from the reception siding over the draw-out track to the incline; after the locomotive of the train has been removed and the brakes have been taken off, the shunting locomotive placed behind the train pushes it to the top of the incline which is between the reception sidings and the sorting sidings, and the cars then run down from there on to the sorting sidings.

As a rule there are two tracks on the incline, which are connected together. This makes it possible to run down cars from both tracks on to any sorting siding desired; this is for instance the case at Linz, Oderberg, Strasshof and Prerau in Austria, and at Kotchetowka in Russia. At the last yard, there are in addition to the sorting sidings secondary sidings for sorting according to station, and next to the latter there is a second small incline over which the cars which have already been sorted on the sorting siding are pushed by a shunting locomotive on to the dead-ended sidings used for sorting according to station. The cars in this case must, as figure 30 shows, move in the reverse direction while they are being sorted according to station.

It has also to be mentioned that at Kotchetowka yard, as also at several Austrian and Hungarian yards, the one track of the incline is higher than the other, so as to make it possible to use a steeper gradient when weather conditions are unfavourable.

Operations at the last-mentioned yards

are quicker and consequently the rolling stock can be utilized better; consequently they represent a material improvement on the older arrangements.

On double-track railways however, the continual growth of the traffic made it more and more apparent that it was objectionable to have the sorting and shunting yards on one side of the main lines only, and that consequently goods trains arriving on the further main line or leaving by it had each time to cross the other line. As this interfered with the safety and the regularity of the working on the other line, this was obviated at some of the newer yards, for instance in Austria at Linz, Oderberg, Prerau and Strasshof, by having two entirely-separate yards, one being used for sorting the trains coming on the one line, and the other being used for the trains coming on the other line.

It is worth notice that at none of the yards built hitherto on this plan, are the tracks of the two halves on each side of the main lines arranged in quite the same way.

This is due firstly to the fact, that in the case of some of these double yards, the existing old yard, with the tracks suitably modified, was retained as the one half. This part of the yard can accordingly not be constructed entirely in accordance with modern principles, while of course when the new part was built for the trains going in the opposite direction all modern improvements could be adopted.

But even in the case of double yards which are wholly new, the tracks on the two sides were not arranged in quite the same way and made of quite the same extent, as the traffic in the two opposite directions nearly always differed in amount and in nature.

Thus for instance the lefthand set of sidings at *Strasshof* yard, Austrian Northern Railway, has as its chief object dealing with the cars coming from Vienna North station, from the Vienna Junction line and from Donau-Ufer station, as well as those coming from the intermediate stations Floridsdorf, Süssenbrunn and Wagram; the cars are sorted according to their destinations in the north.

Five reception sidings were constructed for the purpose on the left hand side and connected over a saddle-back with twelve sorting sidings. The cars which have been sorted can then at once depart, or if sorting according to station is still required, they can be hauled by a shunting locomotive to a draw-out track in connexion, and then pushed back into one of the three existing dead-ended sidings.

The chief sidings on the right hand side are used for sorting the trains coming from the north so that the transit freight can be taken, without being sorted again in Vienna, to the Vienna Junction line and to the Donau-Ufer station; while the local freight, as soon as it arrives in Vienna, can at once be taken to the corresponding stores or warehouses without any shunting operations which would involve loss of time. The sorting sidings on the right hand side are only twelve in number, instead of fifteen.

At the *Prerau* yard the sorting sidings in the one half yard form a continuation of the reception sidings; in the other, they are next to them. In the latter older set of sidings, the cars of the arriving train must accordingly be pushed back on to

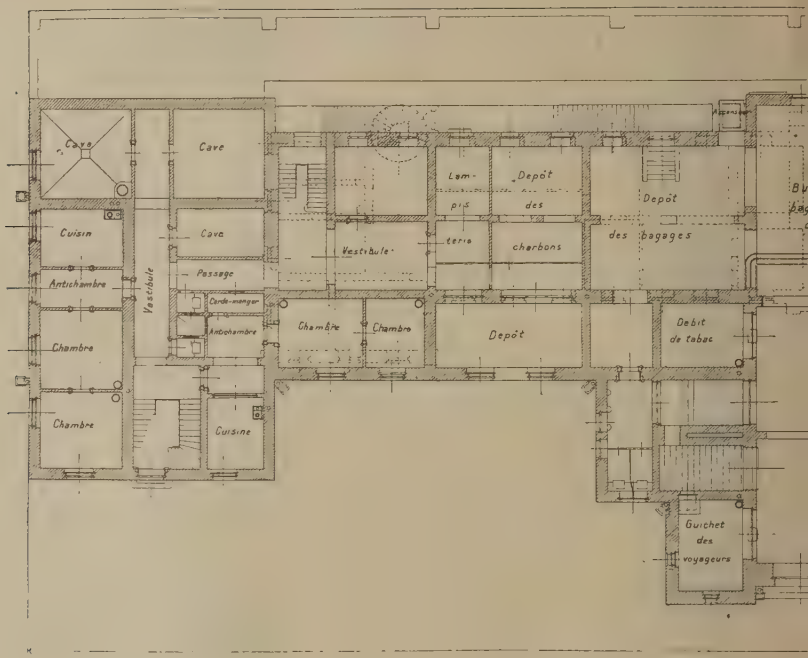
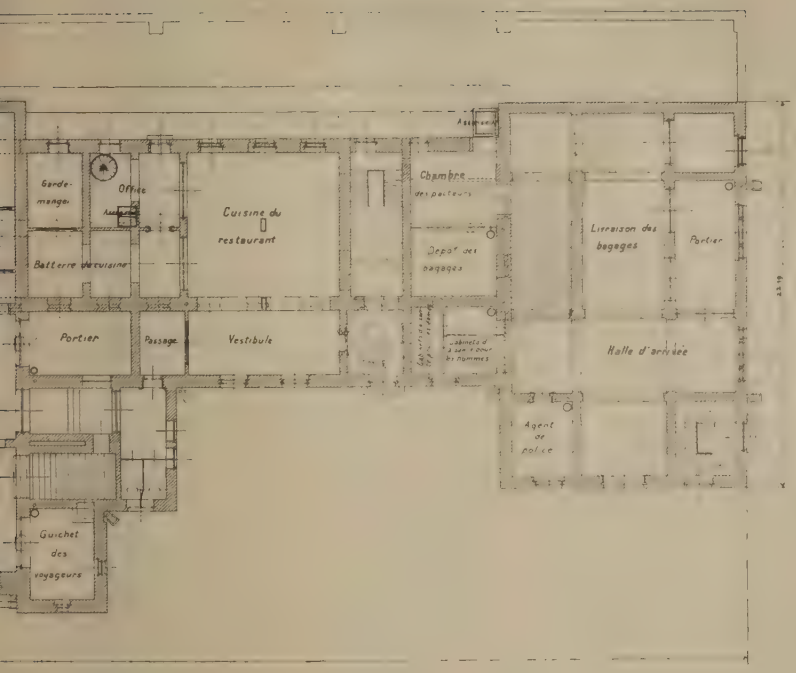


Fig. 22. — Passenger-station

Explanation of French terms : Cave = Cellar. — Cuisine = Kitchen. — Antichambre = Antechamber. room. — Dépôt des charbons = Coal store. — Dépot = Store. — Dépôt des bagages = Cloak roon room. — Office = Servants'hall. — Bureau des bagages au départ = Office for dispatching baggages. Agent de police = Police office. — Portier = Door-keeper. — Cuisine du restaurant = Kitchen o = Lavatories for men. — Batterie de cuisine = Scullery.

the draw-out track of the saddle-back before they are sorted.

At *Oderberg* among the sidings provided on one side of the main lines, for the North-South traffic, the sorting sidings are connected with an incline which forms a continuation of the reception sidings. They are divided into two sets next to each other, the shorter set, without incline, is connected with the set of sidings intended for sorting according to station. The sidings for the South-North traffic are on the other side of the main lines; as less traffic has to be dealt with there are fewer reception sidings, and in their continuation there are also fewer sorting sidings, from which the trains start. There is no incline on this side, nor are there any special sidings for sorting according to station. This installation, which is quite new, thus entirely depends on the use of shunting locomotives; the reason for this is that most of the trains coming from Vienna to Oderberg are



ation. — Plan of ground-floor.

– Garde-manger = Pantry. — Passage = Passage. — Vestibule = Vestibule. — Lampisterie = Lamp
= Tabacconist. — Guichet des voyageurs. = Passenger entrance. — Chambre des facteurs = Porters
= Luggage wicket. — Livraison des bagages = Delivery of luggage. — Halle d'arrivée = Arrival hall.
— Cabinet d'aisance pour les dames = Lavatories for women. — Cabinet d'aisance pour les hommes

going to Prussia and consist of empty returned cars. Only a few of these trains go to the Oderberg auxiliary station and then on to the chief station, and on to the Kassa-Oderberg line, and as consequently shunting operations are but few and also simpler in character, the use of shunting locomotives still gives satisfactory results.

At *Kotchetowka* sorting and shunting yard (Russia) the trains are sorted for the relations Koslów and Saratow to Riasjanj on sorting sidings which form a continuation of the reception sidings, with a saddle-back in between; the sorting sidings are continued into the departure sidings, but without a saddle-back in between. On the other hand, the sorting of the trains going in the opposite direction is effected without incline on sets of sidings which are side by side. The reasons for this difference between the installations for the two directions are partly the local conditions, partly also the fact that the freight traffics in the two

directions are of very different character.

Linz yard, which has already been mentioned, may be included among yards of this type; although some of the arrangements are different, the sorting for the two directions is kept separate.

The Budapest yards are also to be reconstructed on modern principles, in connection with intended reconstruction of the Budapest stations; a new sorting and shunting yard (fig. 10) is proposed, on one side. A saddle-back is to be placed between the reception and the sorting sidings, up which the trains are taken by locomotives. From that saddle-back however, the whole of the work is to be carried out by means of gravity, and the primary and secondary sorting sidings are designed to have gradients of from 5 to 10 per mil. The projected sorting and shunting yard will provide for the general and special sorting and shunting to the chief repairing workshops and to the coal and goods yards, and ample siding accommodation will be provided for cars which require repair, or for cars standing idle at times of little traffic.

Before concluding the consideration of this question, we will mention a few sorting and shunting yards where the usual arrangements were quite impossible owing to the local conditions, such as the proposed auxiliary station at Fiume and the shunting and sorting yards at Budapest-Ferenczáros (fig. 26) and at Dévényujfalu (fig. 32).

The sidings at Fiume, used simultaneously for the passenger, the goods and the shipping traffic, were built near the shore of the Quarnero bay, on marine deposit; they were constructed in successive portions, as the traffic increased. At present however, the station (fig. 33), on the town side is nearly wholly enclosed by hotels, private houses and large industrial establishments, immediately behind which steep hills rise, so that any land required for extending the station could only be obtained by the very expensive method of reclaiming it from the sea.

It was not possible to provide inclines for the existing sidings owing to local conditions; locomotives must therefore be exclusively used. The continual growth of the goods traffic makes it very difficult to sort, according to store and warehouse, the many cars coming from Budapest, and similarly to sort the oversea traffic arriving there, according to direction. The extensions which have at present been begun will probably not suffice; it has accordingly been proposed to build an auxiliary sorting and shunting yard. Owing to the unfavourable conditions mentioned, it will however not be possible to have this yard in the immediate neighbourhood of Fiume and connected with that station. The solution adopted is therefore as follows: the freight arriving at Fiume by sea and going inland is sorted at Fiume station, which is enlarged as much as possible; the goods trains coming from inland to Fiume are sorted at a new sorting and shunting yard near Buccari station, about 10 kilometres (6·2 miles) from Fiume.

Now as this yard is only to be used for the sorting operations in the one direction, the plans could be better suited to the local conditions and requirements. The trains going to Fiume have to leave Buccari station on a special track leading to the reception sidings, which also serve as departure sidings, and are provided at

each end with turn-outs. From here the row of cars is hauled by a locomotive on to a horizontal draw-out track from which the cars are then distributed, by the same locomotive, without using an incline, to the separate tracks of the sorting sidings.

The traffic to be dealt with at Fiume station is divided into five chief sections, and one siding is provided for each section. If the row of cars intended for one such chief section does not require any further sorting according to store or warehouse, it can either start at once from the sorting siding in question, or be hauled to the departure sidings and then start from there. If however the cars which are on one and the same sidings still require further sorting according to store or warehouse, the row of cars is hauled by a shunting locomotive to a second draw-out siding and then distributed from here to the separate tracks of the second set of sidings. The cars collected in this way on the different tracks of the second set of sidings, are then hauled out by the shunting locomotive in their proper order by means of the second draw-out sidings and formed into a train, which then starts either from the sorting sidings themselves or from the departure sidings. These two sets of sorting operations can be carried out simultaneously and independently of each other.

A second track is at present being laid between Buccari and Fiume, where the down-gradient of the railway is 25 per mil. The track which connects Buccari station with the new sorting and shunting yard has a down-gradient, partly of 10 and partly of 25 per mil, while the reception sidings together with all sorting sidings and the draw-out tracks are on the flat. The track from the end of the yard to its junction with the Fiume main line also has a gradient of 25 per mil. Inclines are not provided, partly because this would be very expensive, partly because of local conditions.

The sorting and shunting yard, in spite of the simplicity of the proposed design, will cost about 3 million kronen (£124,800), as in some cases a depth of 20 metres (65 ft. 7 in.) will have to be filled in. It was however necessary to select the place in question for the installation, for the Karst country through which the railway runs is so irregular that the next suitable place was at a distance of 90 kilometres (56 miles), and the interests of the proper operation of the traffic precluded having the sorting and shunting yard at such a great distance from Fiume.

The *Budapest-Ferenczváros* sorting and shunting yard (fig. 26) only differs from the usual type as regards its location. This yard is provided for sorting the traffic from the Budapest goods yards, and from the other sorting yards, for the directions Belgrad, Vienna, Fehring, Fiume and Sarajevo, and also the traffic coming from those directions to Budapest, and also that passing through Budapest. As local conditions made it impossible to have the sorting and shunting yard along side and parallel to the existing station, it was necessary to construct it at right angles to it.

At both ends of the station branches curve off to the set of sidings which serve both as reception and as departure sidings, so that a triangle is formed.

The shunting locomotives haul the row of cars which are to be sorted up the

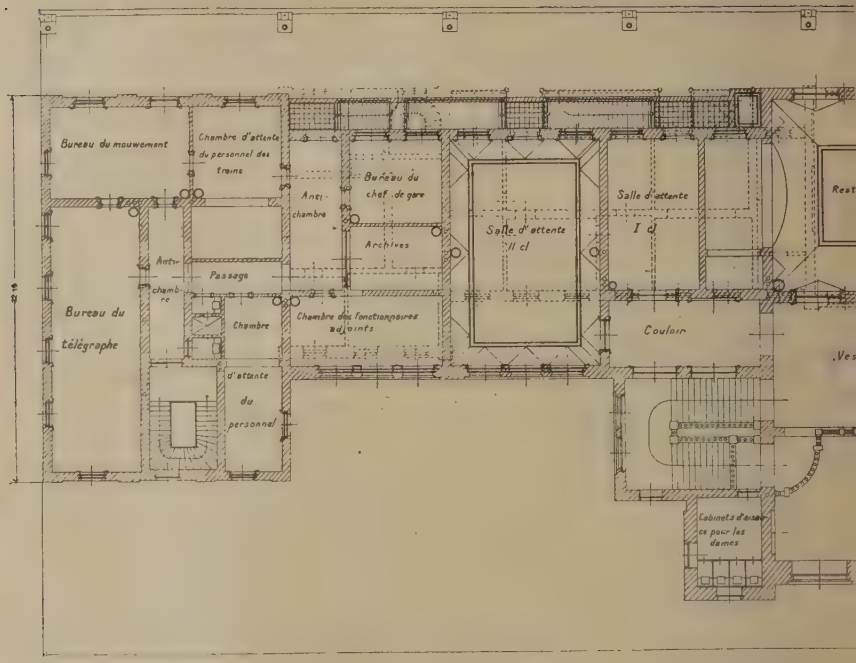


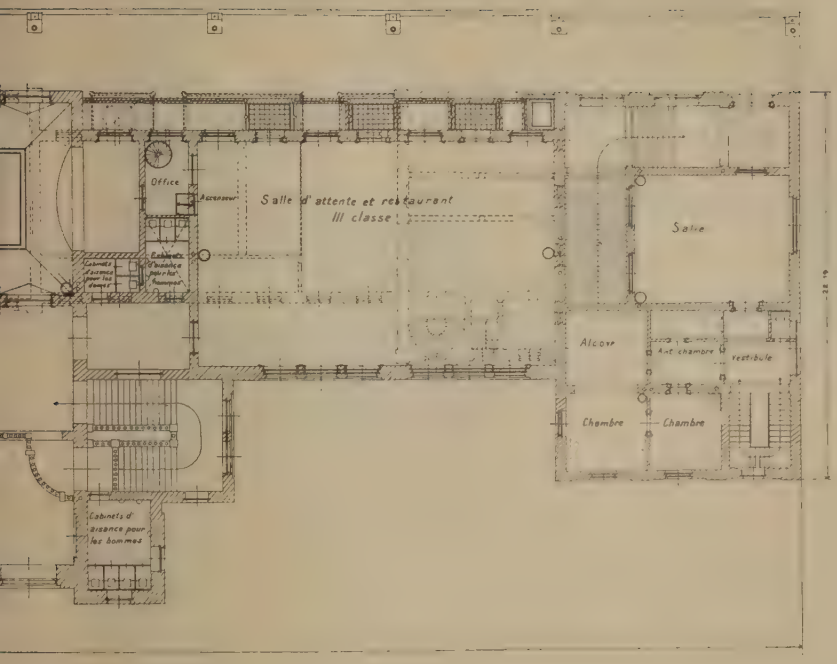
Fig. 23. — Passenger-station buildi

Explanation of French terms : Bureau de mouvement = Traffic office. — Bureau de télégraphe = Telegra staff. — Passage = Passage. — Chambre d'attente du personnel = Waiting room for staff. — Bureau d for assistant officials. — Salle d'attende II cl. = Waiting room, II[nd] class. — Salle d'attente I cl. = Wa Cabinets d'aisance pour les hommes = Lavatories for men. — Couloir = Corridor. — Restaurant de I = Waiting and refreshment room, 3[rd] class. — Office = Office. — Chambre = Room. — Alcôve = Alc

draw-out track of the incline; from this the cars run down the incline to the sorting sidings, which are parallel to the reception sidings. At the other end of the sorting sidings there is a draw-out track on the flat, and a second shunting locomotive can then if necessary in the same way effect the sorting according to station, and then take the sorted rows of cars on to the departure sidings, from which the trains can start.

A great disadvantage of this arrangement is that the trains which have arrived have to be hauled backwards, and that there are no special sorting sidings for sorting according to station; but the chief disadvantage is that the sorting and shunting operations can not be carried out independently of the arriving and departing trains.

Dévényujfalu station in Hungary is between Pozsony and Vienna in the neighbourhood of the Austrian frontier, and the numerous goods trains coming from



ged station. — Plan of first floor.

· Antichambre = Antechamber. — Chambre d'attente du personnel des trains = Waiting room for train are = Office of station-master. — Archives = Records. — Chambre des fonctionnaires adjoints = Room I[st] class. — Vestibule = Vestibule. — Cabinets d'aisance pour les dames = Lavatories for women. — = Refreshment room, I[st] and II[nd] class. — Ascenseur = Lift. — Salle d'attente et restaurant III cl. = Hall.

both directions have to be sorted there. Conditions are here more favourable for an installation which is chiefly on a down gradient, similar to that at Dresden-Friedrichstadt, than for one which is on the flat; while it would have been very expensive to have a yard on a continuous gradient, in a longitudinal direction, as for instance at Nuremberg. The scheme shown in figure 32 was therefore adopted.

There are reception sidings which are used for trains coming from both directions; the rows of cars are hauled from here over a draw-out track having a gradient of 13·5 per mil to sidings having a gradient of 8 per mil; the separate cars are then run by gravity to the sorting sidings, which have gradients of 10·8 and 10 per mil. Those rows of cars which require no further sorting are likewise run by gravity, no locomotive being used, to the departure sidings, which at first have a gradient of 10 per mil, then one of 5 per mil, and are finally on the flat; and

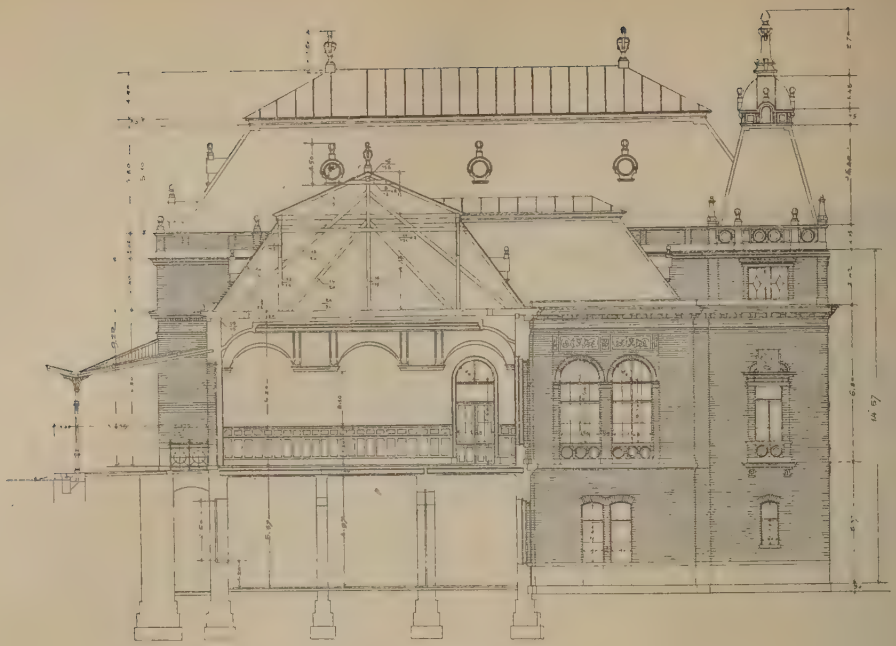


Fig. 24. — Section *a-b*.

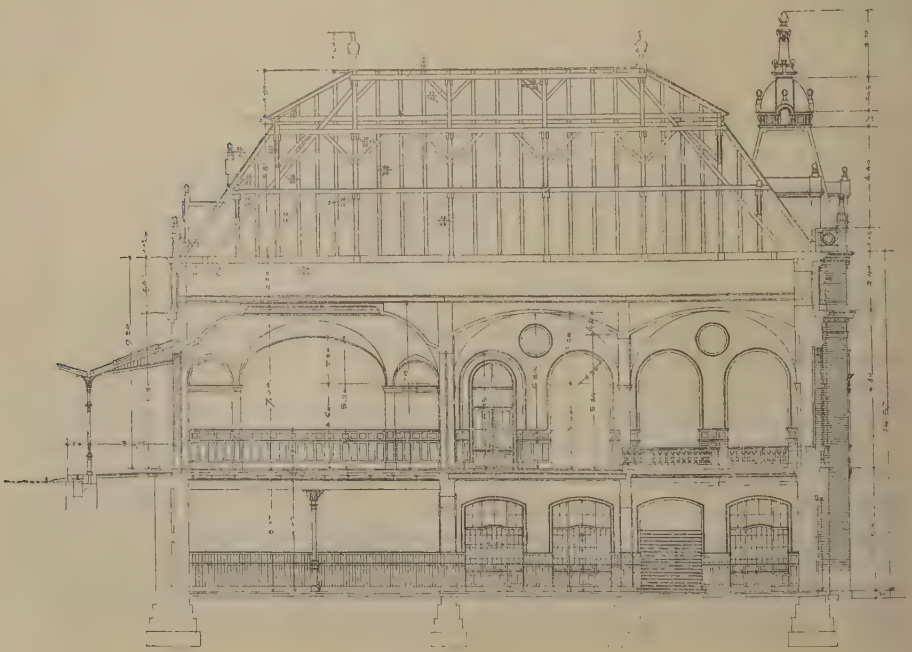


Fig. 25. — Section *c-d*.

Figs. 24 and 25. — Hungarian State Railway. Passenger-station building, Szeged station.

Explanation of French terms : Voie de tirour = Draw-out track. — Faisceau de triage suivant la direction = Set of sidings for sorting according to direction. — Faisceau d'arrivée et de sortie = Set of reception and departure sidings. — Dortoirs = Sleeping quarters. — Chateau d'eau = Water tower. — Hangar = Shed. — Voies d'arrivée et de sortie = Tracks for arriving and departing. — Poste d'aiguilles = Switching point. — Rampe découverte = Open ramp. — Hangar à marchandises = Goods shed. — Bâtiment des voyageurs = Passenger-station building. — Depôt des locomotives = Locomotive shed. — Hangar à charbon = Coal shed. — Rampe de désinfection = Desinfecting ramp. — Gare à voyageurs = Passenger station. — Voie de marchandises = Goods sidings.

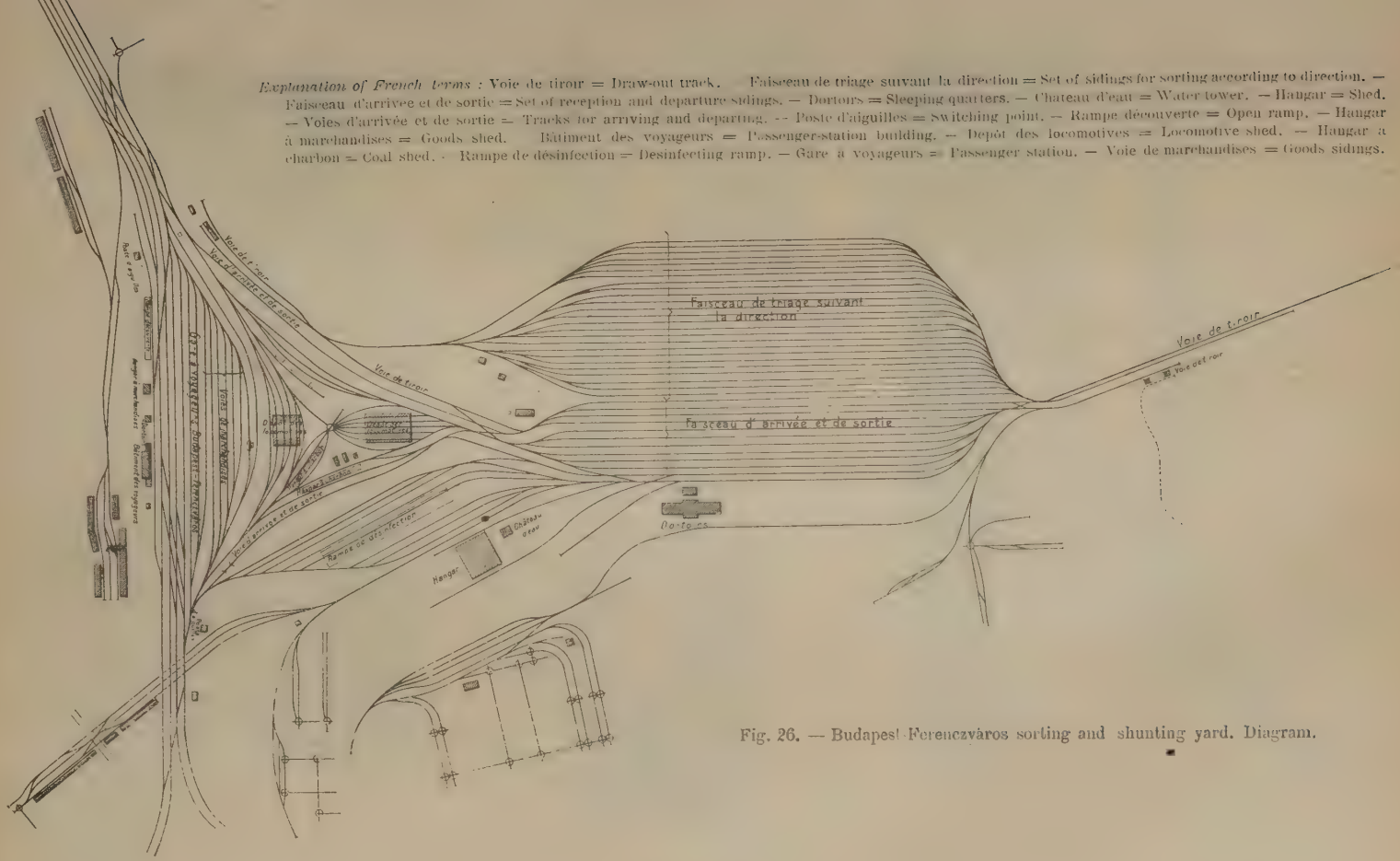


Fig. 26. — Budapest-Ferenczváros sorting and shunting yard. Diagram.

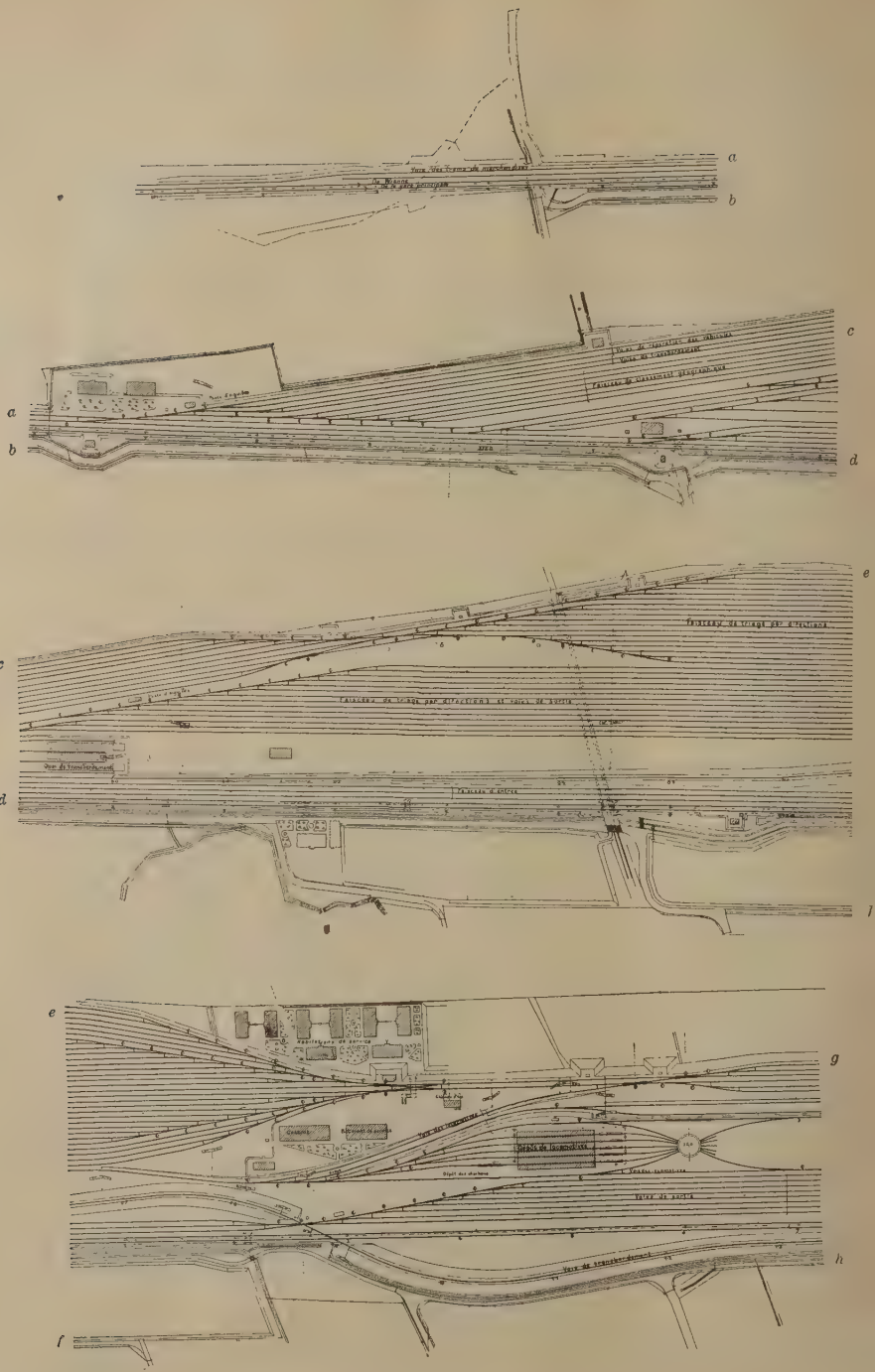


Fig. 27. — Oderberg sorting and shunting yard.

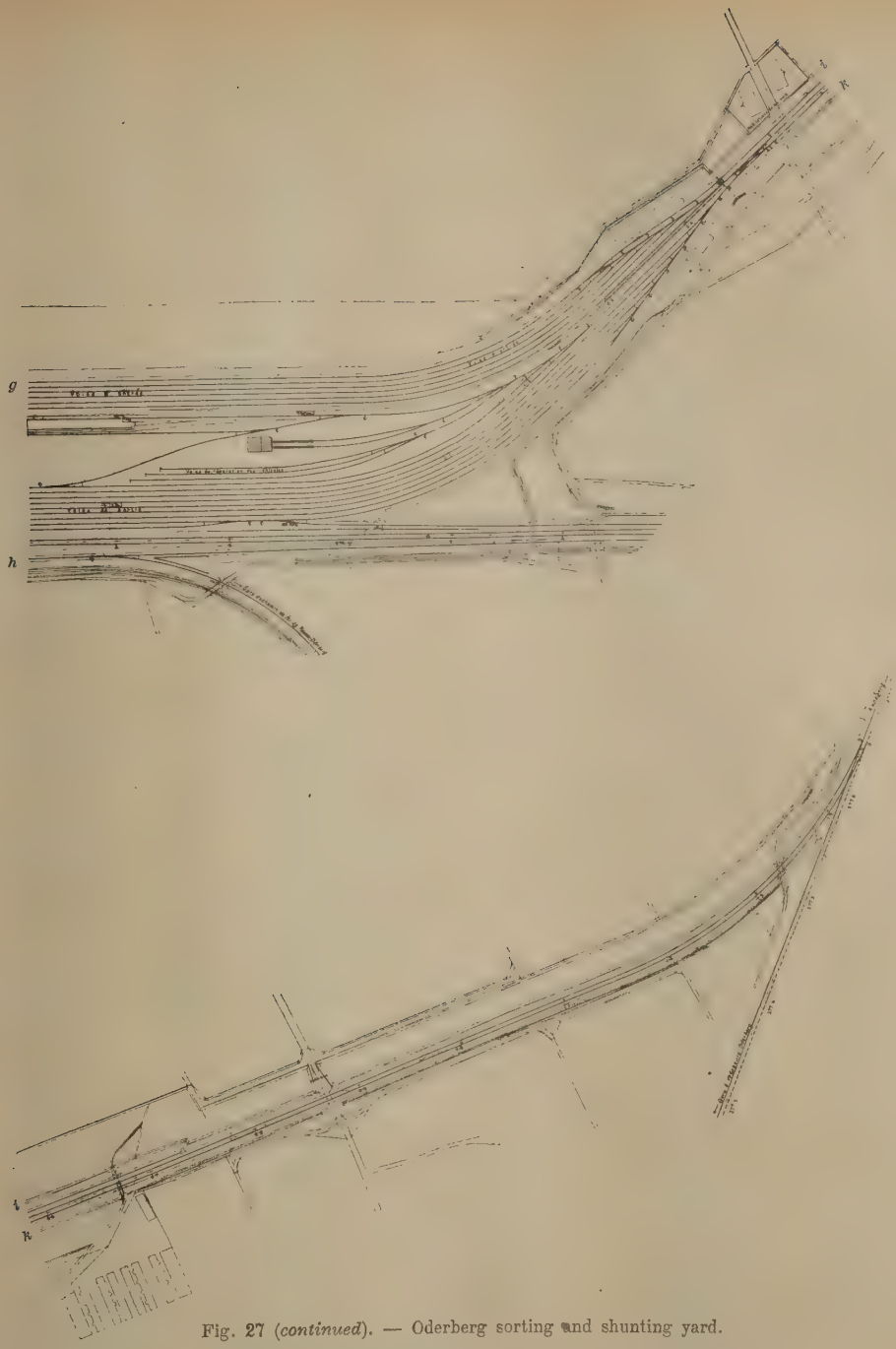
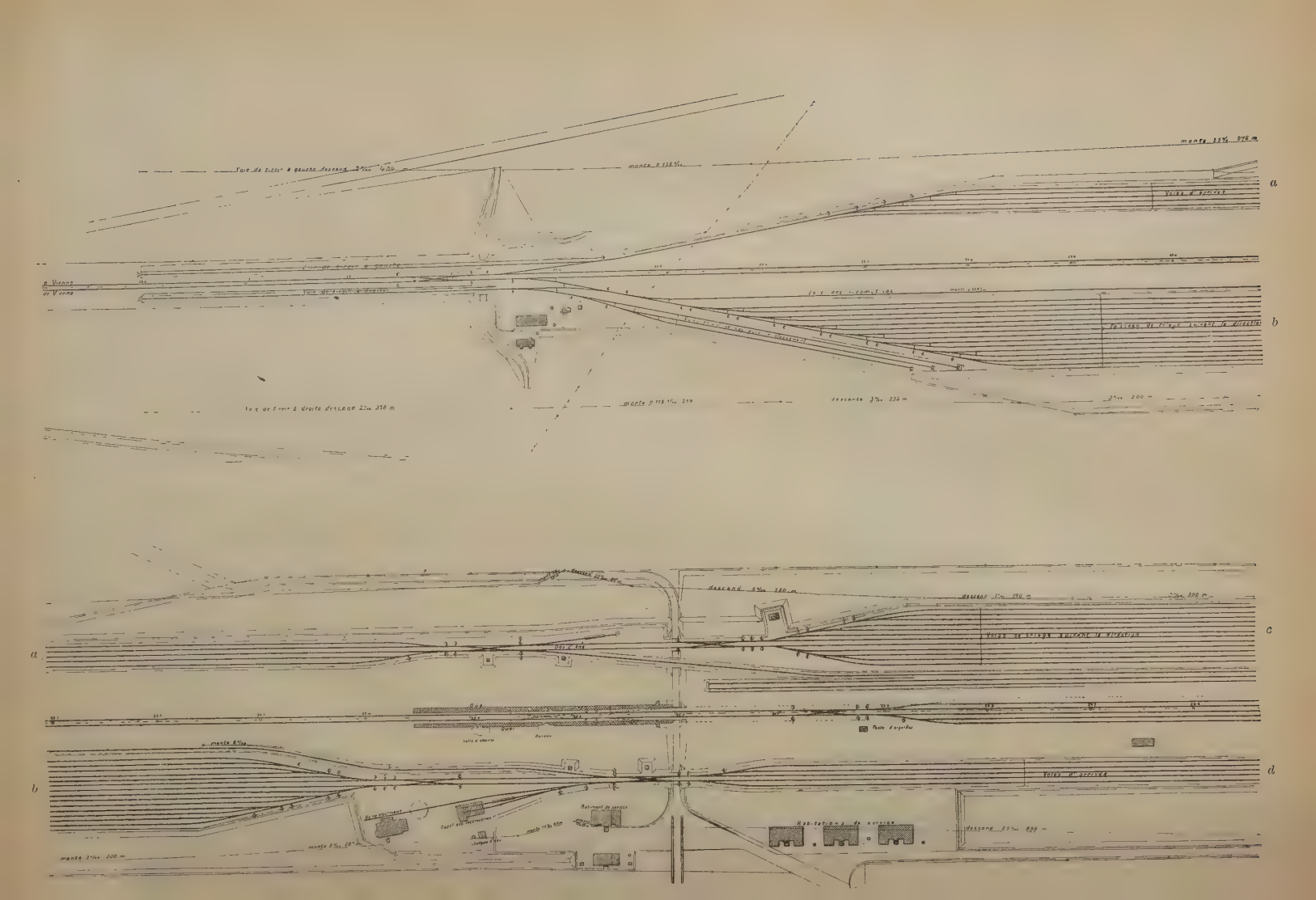


Fig. 27 (*continued*). — Oderberg sorting and shunting yard.

Explanation of French terms: Voie des trains de marchandises = Lines for goods trains. — De Vienne = From Vienna. — De la gare principale = From the chief station. — Poste d'aiguilles = Switching point. — Voies de réparation des véhicules = Sidings for repairing cars. — Voies de transbordement = Tranship sidings. — Faisceau de classement géographique = Set of sorting sidings. — Quai de transbordement = Tranship platform. — Faisceau de triage par directions et voies de sortie = Sidings for sorting according to direction. — Faisceau de triage par directions = Sidings for sorting according to direction and departure sidings. — Faisceau d'entrée = Reception sidings. — Habitations de service = Houses for staff. — Château d'eau = Water-tower. — Dépôt de locomotives = Locomotive shed. — Voie des locomotives = Locomotive siding. — Dépôt des charbons = Coal yard. — Voies de sortie = Departure sidings. — Caserne = Staff quarters. — Bâtiment de service = Service buildings. — Gare du chemin de fer de Kaschau-Oderberg = Station of Kaschau-Oderberg Railway. — Gare à voyageurs Oderberg = Oderberg passenger station.


a
b
c
d
Voies de garage
Voies de service
Voies de triage
Bâtiment de service
Habitations de service
Halle d'attente
Bureaux
Poste d'aiguilles
Descend 5‰ 220 m
Descend 5‰ 196 m
Descend 23‰ 838 m
monte 5‰ 220 m
monte 2‰ 200 m
monte 13‰ 976 m
descente 3‰ 232 m

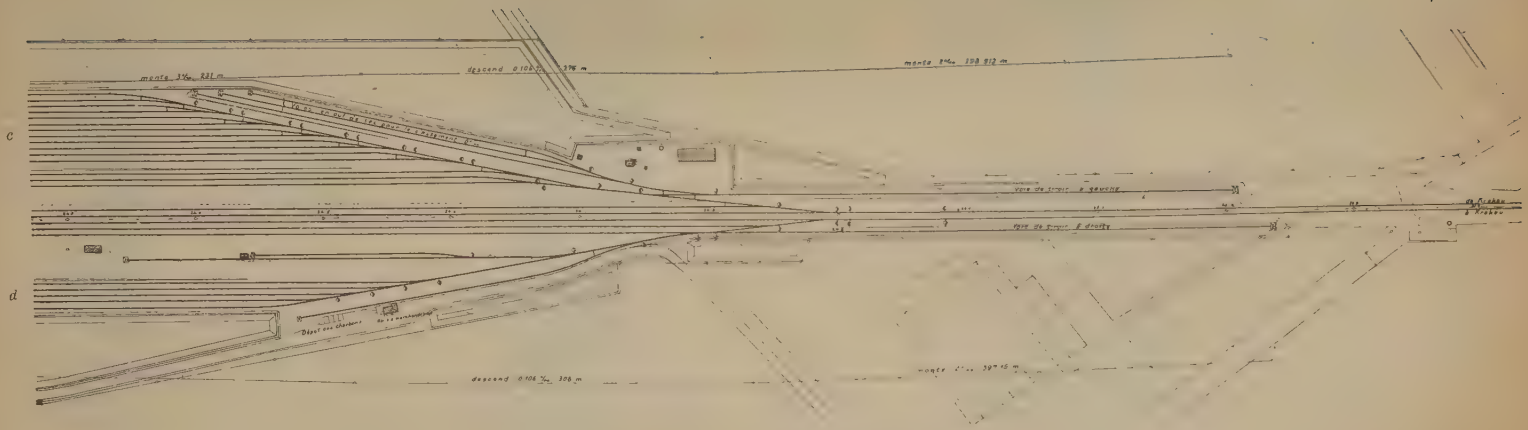


Fig. 28. — Strasshof sorting and shunting yard.

Explanation of French terms : Voie de tiroir à gauche descend 2 °/₀₀ = Left draw-out track. Descent 2 per mil. — Voie de tiroir à gauche = Left draw-out track. — Voie de tiroir à droite = Right draw-out track. — Voie de tiroir à droite descend 2 °/₀₀ = Right draw-out track. Descent 2 per mil. — Monte 0.125 °/₀₀ = Ascent 0.125 per mil. - Voies en cul-de-sac pour le classement = Dead-ended sorting sidings. — Voie des locomotives = Locomotive siding. — Descente 3 °/₀₀ = Descent 3 per mil. — Monte 2,5 °/₀₀ = Ascent 2·5 per mil. — Voie d'arrivée = Reception sidings. Faisceau de triage suivant la direction = Set of sidings for sorting according to direction. — Dos d'âne = Saddle-back. — Quai = Platform. — Salle d'attente = Waiting room. — Bureau = Offices. — Poste d'aiguilles = Switching point. — Habitations de service = Houses for staff. — Usine électrique = Electrical machinery. — Dépôt des locomotives = Locomotive shed Château d'eau = Water-tower. — Bâtiment de service = Service buildings. — Dépôt des charbons = Coal yard. — Halle à marchandises = Goods shed.

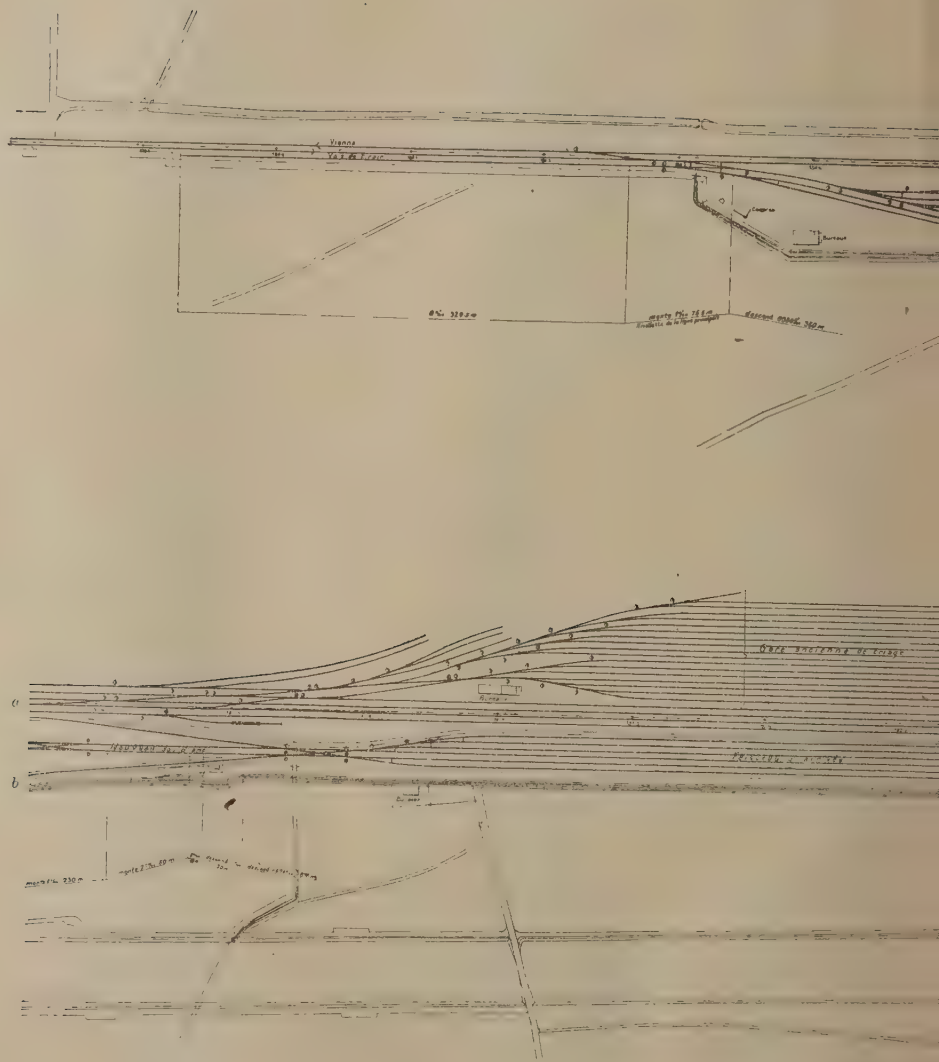
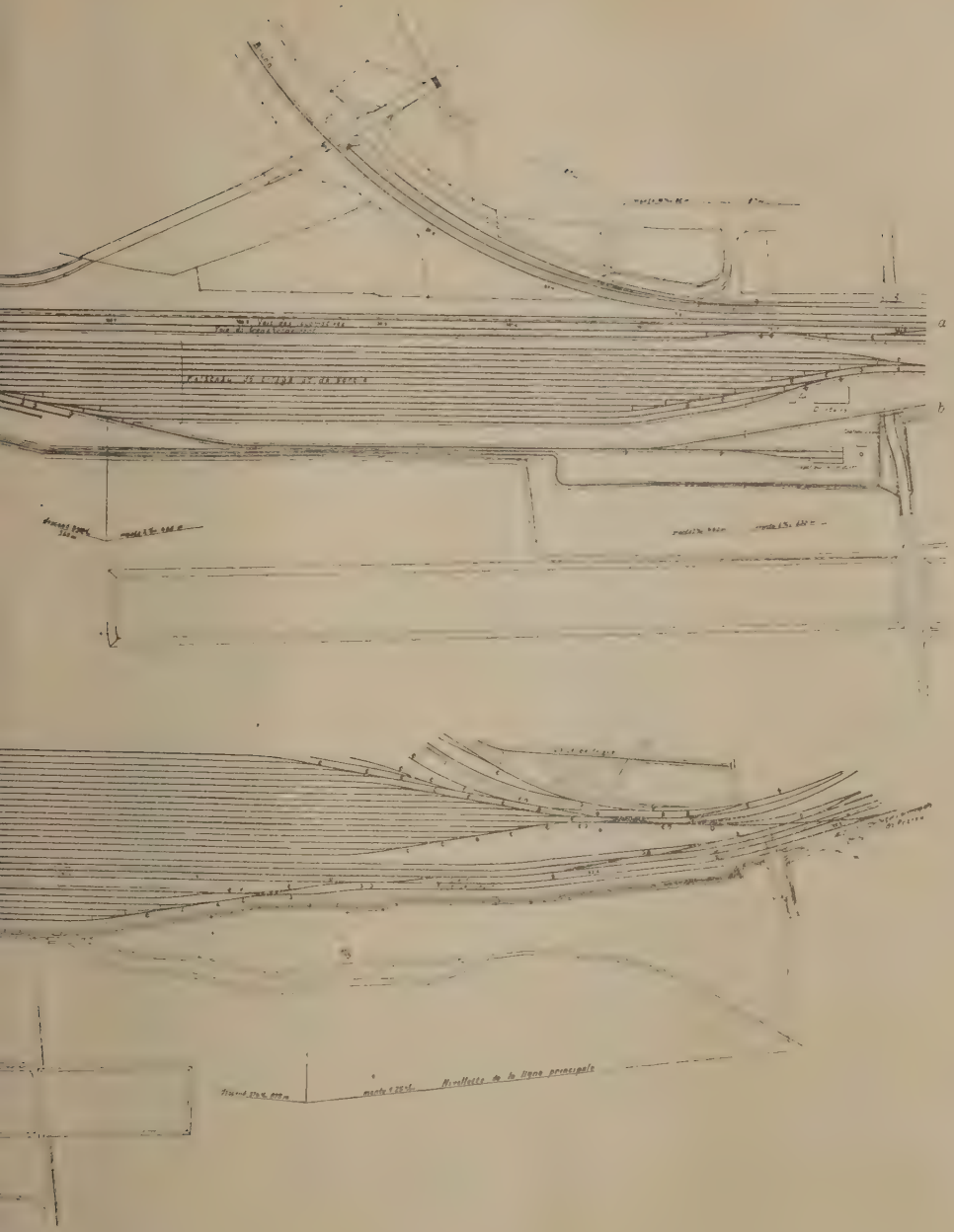


Fig. 29. —

Explanation of French terms : Vienne = Vienna. — Voie de tiroir = Draw-out track. — Nivelette de la ligne principale
siding. — Voie de transbordement = Transhipp siding. — Faisceau de triage et de sortie = Sorting and depart
Gare ancienne de triage = Old sorting and shunting yard. — Faisceau d'arrivée = Set of reception sidings. —



l shunting yard.

ne. — Caserne = Staff-quarters. — Bureau = Offices. — Dortoir = Sleeping quarters. — Voie des locomotives = Locomotive
des locomotives = Locomotive shed. — Château d'eau = Water-tower. — Nouveau dos d'âne = New saddle-back. —
Electrical machinery. — Gare principale de Prerau = Prerau chief station. — Monte = Ascent. — Descend = Descent.

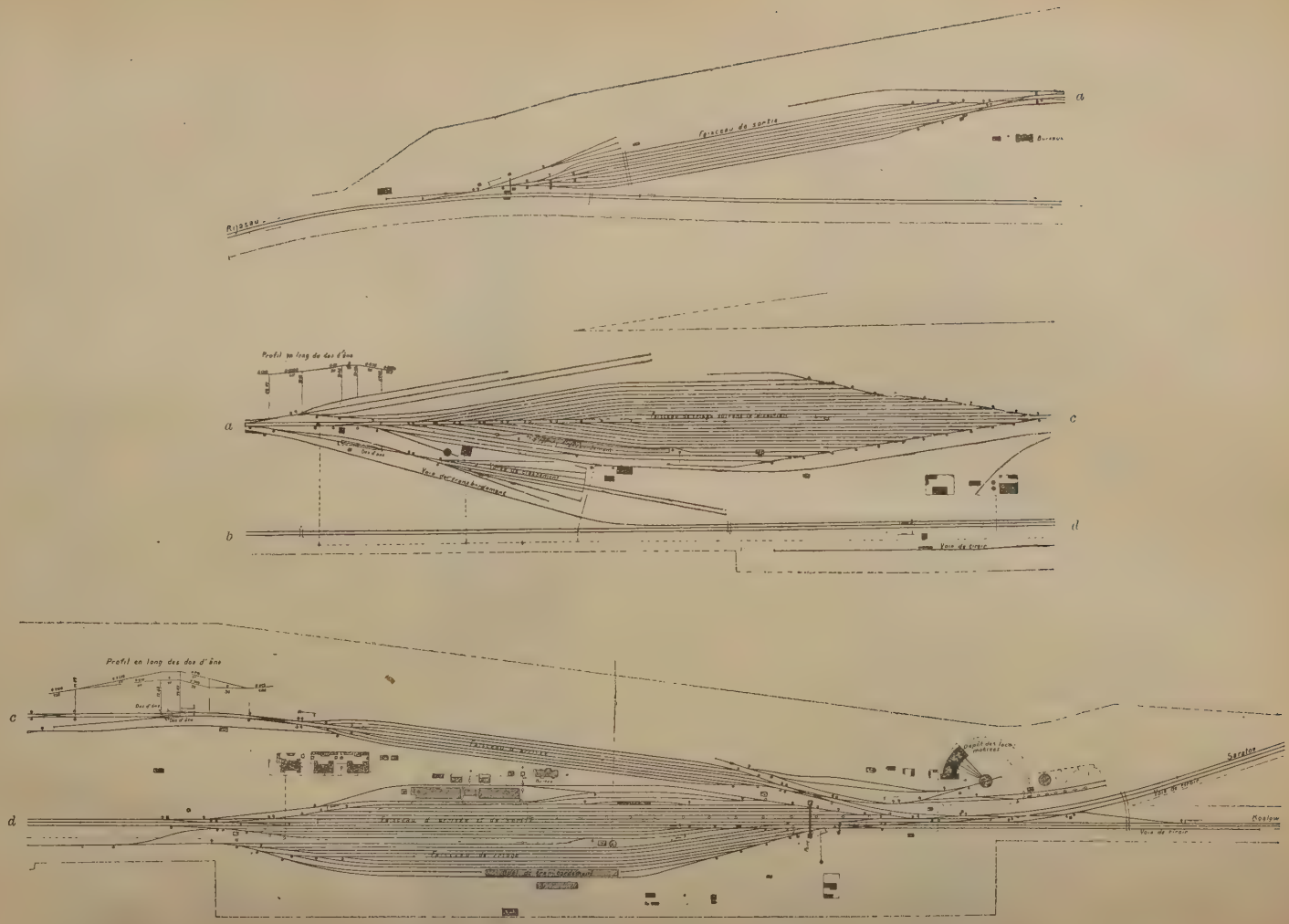


Fig. 30. — Kotchetowka sorting and shunting yard.

Explanation of French terms: Faisceau de sortie = Set of departure sidings. — Bureaux = Offices. – Profil en long du dos d'âne = Profile of saddle-back. – Faisceau de triage suivant la direction = Set of sidings for sorting according to direction. — Dos d'âne = Saddle-back. – Voie de transbordement = Tranship siding. — Voie de classement

the trains can start from here. The sorting according to station is also carried out on tracks which have a gradient of at first 10 per mil and then of 8 per mil; after the cars have been sorted in this way they are hauled by locomotives to the draw-out track and then pushed back to the departure sidings.

Thus the sorting operations at this station are only partly carried out by locomotives, but it was not possible to avoid repeated movements wholly, as under the existing local conditions it would have been exceedingly expensive to make the sorting yard longer.

Question 1-*b*). — *What system is adopted for stopping and again starting the cars in the two cases mentioned above (hand brakes, sprags, skids, etc.)? Are all the cars which are shunted at yards with continuous inclines, fitted with hand brakes? How is the work carried out when this is not the case?*

Hand brakes, sprags and skids are all used at the yards in the countries with which our report deals.

As regards skids, the Büssing skid is used nearly exclusively; in Russia however the Weber skid and several French skids are also used.

More recently rail brakes have also been used, at Oderberg and Strasshof yards, at the entrances to the gridirons forming the sorting sidings; these seem to be the most suitable means for preventing collisions between cars running at different speeds. When they are used, the inclines can be made higher, and this accelerates the sorting operations. The rail brakes used here are on the Büssing system.

Sprags are nearly exclusively used at the sorting and shunting yards on the flat, where there are no inclines.

At some stations, for instance at several Russian stations, sleepers are laid in front of the wheels of the cars which have been stopped; these sleepers have grooves cut in them, to correspond with the rail heads, and their object is to prevent the cars which are standing still from moving. At some places sand is placed on the rails of the sorting sidings, in order to moderate the speed of the moving cars.

As there are no yards with continuous inclines in the countries with which our report deals, the question concerning the brakes used at such yards requires no answer.

Question 1-*c*). — *What arrangements are adopted for stopping run-aways (chain drags, safety sidings, sand tracks, etc.)?*

No such arrangements have as yet been adopted in the countries with which our report deals. Run-aways are fetched back by the locomotive.

Question 2. — *Have you adopted any arrangement of tracks making it possible to eliminate any interruption of the shunting, sorting and making-up operations owing to the arrival and departure of trains?*

In all cases where local conditions and the resources available made it possible, it was tried to make the sorting, shunting and making-up operations independent of the arrival and departure of the goods trains.

*

Fig.

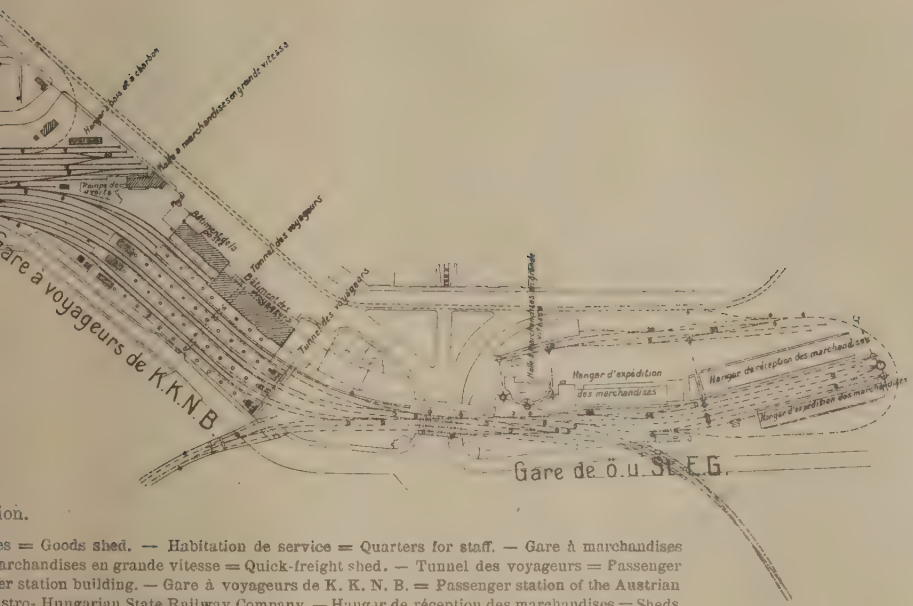
Explanation of French terms : Voie de tiroir = Draw out track. — Dépôt des locomotives = Locomotive shed. -
de K. K. N. B. = Goods yard of the Austrian Northern Railway. — Hangar à bois et à charbon = Wood and c
subway. — Rampe découverte = Open ramp. — Bâtiment de la poste = Post-office building. — Bâtiment des
Northern Railway. — Hangar d'expédition des marchandises = Sheds for forwarding goods. — Gare de ö. u. St. F
for receiving goods.

With this object in view, at sorting and shunting yards on the flat, where locomotives were used for the operations, at least one and in some cases several draw-out tracks were constructed at both ends of the sorting sidings, to the right and to the left of the reception sidings and of the departure sidings, which made it possible to carry out the operations within the left-hand or the right-hand set of sidings quite independently of the arrival and departure of the trains. Attempts were also made to increase the capacity of such sorting and shunting yards in the case of double-track railways by laying special tracks from the nearest station to the yard and from the latter to the next station.

This question was solved in several different ways in the case of the different types of sorting and shunting yards with inclines which have been described above.

At many yards, for instance at Oderberg, Prerau, Strasshof and Kotchetowka, two separate sets each of reception, sorting and departure sidings have been constructed, on which the cars are sorted in the opposite directions, and where trains to or from opposite directions can not cross each other.

At Linz, on the other hand, the cars brought by the trains coming from the two opposite directions move only in one direction during the sorting operations; they are however kept quite separate, and the arrival and departure of the trains is also quite separate in both directions and


Gare à voyageurs de K.K.N.B.
Tunnel des voyageurs
Hangar d'expédition des marchandises
Hangar de réception des marchandises
Gare de ö.u. St.E.G.

ion.

es = Goods shed. — Habitation de service = Quarters for staff. — Gare à marchandises
archandises en grande vitesse = Quick-freight shed. — Tunnel des voyageurs = Passenger
er station building. — Gare à voyageurs de K. K. N. B. = Passenger station of the Austrian
stro- Hungarian State Railway Company. — Hangar de réception des marchandises = Sheds

does not interfere with the sorting operations. The same arrangement is also to be adopted at the projected chief sorting station and shunting yard at Budapest.

Keeping the tracks for the passenger traffic and the tracks for the goods traffic entirely separate up to the neighbouring stations also tends to accelerate the goods traffic and to promote the quicker circulation of the cars. The measure is therefore of great importance from the point of view of the better utilization of the rolling stock.

Question 3. — *What importance do you attach to the realization of the different preceding conditions (uniform direction of movement of the cars which are being sorted, independence of the operations of the arrival and the departure of the goods trains)?*

There is no doubt that railway men have for a long time already attached great importance to installations making possible the uniform direction of movement of the cars which are being sorted and the independence of the operations.

Comparative calculations have shown that the extra cost incurred in the construction of such sorting and shunting yards, owing to their greater size, is already counterbalanced in a few years by the saving in working expenses, as with properly-arranged yards the shunting locomotives have to travel much shorter

distances than at yards which are not so well arranged.

It also much more rarely happens that cars or goods become damaged, so that car repairs cost less and there are fewer claims for compensation. It must not be forgotten that in consequence of the smaller number of cars which require repair, the number of cars available is increased. Finally it has to be mentioned that properly-arranged yards are more easily supervised, so that the number of accidents is reduced and a smaller staff is required for supervision.

That in spite of this, some of the older sorting and shunting yards have not been reconstructed is probably due to the fact that this very expensive reconstruction will only pay if the number of cars arriving exceeds 1,500 to 2,000 per day. Then also the different railway administrations are, as already stated, occupied in the first place with satisfying other, more urgent, needs, and the great financial resources which are necessary for reconstructing the sorting and shunting yards can only be raised gradually.

Question 4. — *Please describe the following mechanical appliances, in so far as they are used : a) At sheds where there is one floor only (capstans, cranes, traversers, etc.); b) At sheds where there are several floors (cranes, lifts, conveyor belts, mechanically-operated trucks, etc.).*

At the single-floor sheds of the stations with which our report deals hand-carts only are used for loading and unloading packages. At the larger sheds wall cranes and travelling cranes are in use, all as a rule being hand-operated.

There are but few cases of goods sheds with several floors, the reason being that it is only of late that operations in such high buildings have become simplified by the use of lifts, shoots, wall cranes and travelling cranes, and that a better utilization of space only became necessary in course of time.

We may mention among many-floor sheds those at Triest, Fiume, Brünn, and at Vienna South station.

The *Triest*, goods yards sheds were formerly not the property of the railway, but belonged till lately to the city and to the commercial chamber jointly. They have only recently been acquired by the State, which now operates them. In 1903 a credit of 87 million kronen (£3,619,200) was granted for the extension of Triest harbour; the works are to include twenty-two goods sheds, several of which are to have several floors. In addition, eight warehouses are provided for, several of which are to have three floors and a cellarage underneath; some of these are already in use. The cranes, capstans and lifts used in these warehouses, as well as the turntables, are operated by hydraulic power. The water is at a pressure of 55 atmospheres, and there are three accumulators; it flows through the circuit formed by the high-pressure and the return pipes and only requires filling up to the extent of about 5 per cent.

As a typical instance of these warehouses we will describe the general arrangement of warehouse No. 26. The outer walls are made of rubble masonry and the floors are built with iron girders and concrete jack arches, supported in the case of the ground floor on masonry piers, and it that of the upper floors on iron

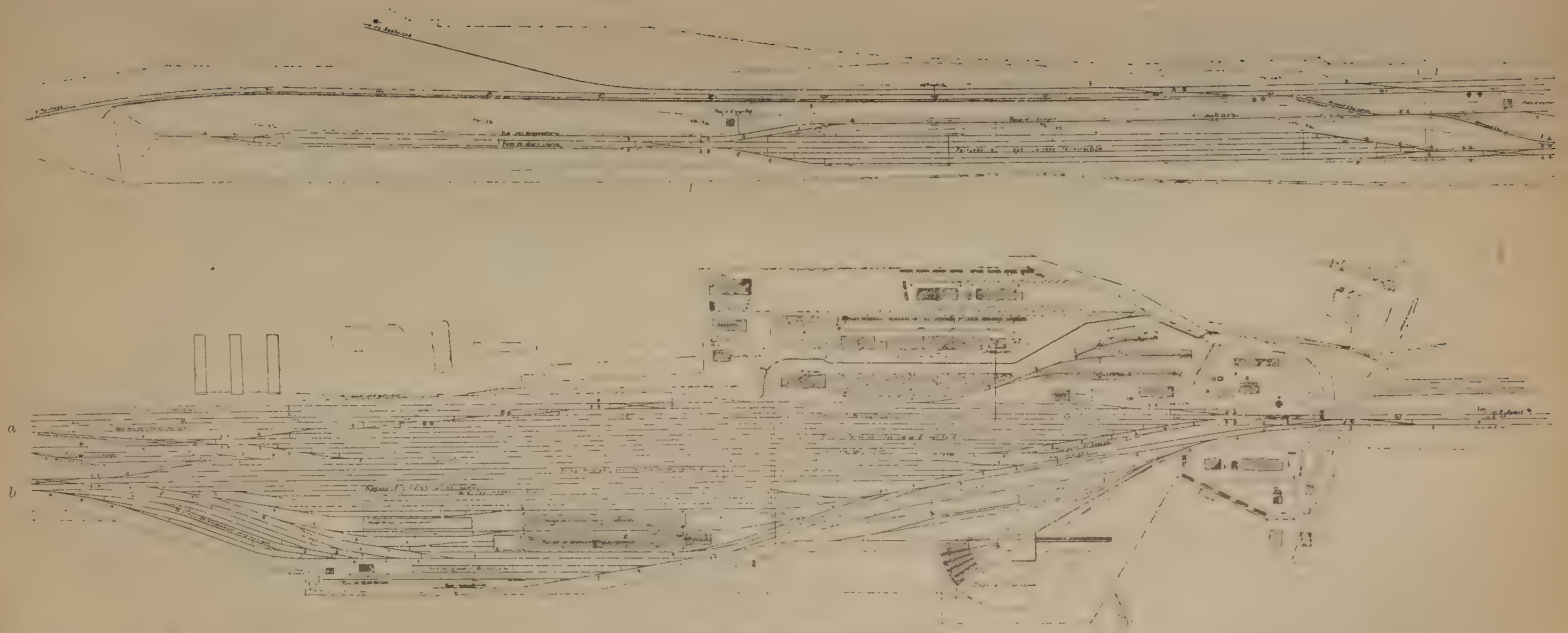


Fig. 32. — Dévényujfalu sorting and shunting yard.

Explanation of French terms : Voie des locomotives = Locomotive siding. — Voies de débranchement = Making-up siding. — Poste d'aiguilles = Switching point. — Faisceau de triage suivant la direction = Set of sidings for sorting according to direction. — Voie de tiroir = Draw-out track. — Voie de départ = Departure track. — Voie de garnitures de train = Sidings for made-up trains. — Entrée des trains de marchandises = Entrance of goods trains. — Fourgons de bagages = Luggage vans. — Voie industrielle = Works railway. — Wagons des marchandises locales = Local goods wagons. — Voie des wagons vides = Track for empty wagons. — Voie de départ pour les trains de marchandises = Departure sidings for goods trains. — Faisceau de classement géographique = Sorting sidings. — Voie de désinfection = Disinfecting siding. — Voie de transbordement ouverte = Open transhipping ramp. — Voie de réparation des véhicules = Siding for repairing cars. — Rampe de transbordement couverte = Covered transhipping ramp. — Dortoirs = Sleeping quarters. — Usine électrique = Electrical machinery. — Habitations de service = Houses for staff. — Château d'eau = Water-tower. — Trains de voyageurs = Passenger trains. — Voie d'entrée pour les trains de marchandises = Reception sidings for goods trains. — Magasin = Store. — Rampe = Ramp. — Dépôt de charbons = Coal yard. — Dépôt de locomotives = Locomotive shed.

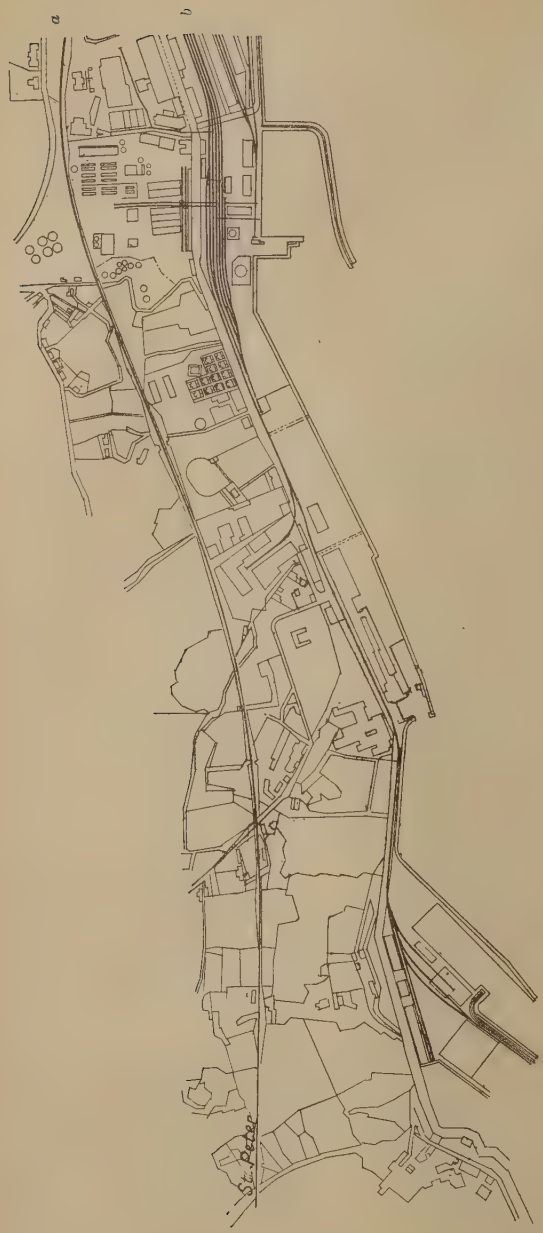

St. Peter
Hangar
Hangar
Bâtiments voyageurs
Marché
Hôpital
Gare de Metz

Fig. 33. — Fiume harbour station.

Explanation of French terms : Gare de triage = Sorting buildings. — Hangar = Shed. — Gare à voyageurs = Passenger station. — Bâtiment des voyageurs = Passenger station building. — Gare à marchandises = Goods yard. — Tunnel = Tunnel.

columns. The admissible load amounts on the first, second and third floor to 1,800 kilograms per square metre (368·65 lb. per square foot), and on the top floor to 800 kilograms per square metre (163·85 lb. per square foot) and on the outer passages to 600 kilograms per square metre (122·88 lb. per square foot); notice-boards are hung up indicating them. The goods are brought in through the upper doors by a hydraulically-operated wall slewing crane able to lift 1,200 kilograms (2,645 lb.), and the hydraulic lift can deal with the same loads. The latter have cage supports at each floor, and they are all operated from one spot on the ground floor. The operator gives and receives the necessary directions through three speaking tubes. The shaft lining consists of corrugated plate; self-closing shaft doors are however not in use. In addition to the wall slewing cranes there is also a travelling crane working from the ceiling.

The warehouse at *Brünn* station (figs. 34 to 38) also has several floors; and there are electrical lifts, the position of which is shown in the figures.

At *Vienna South station* a new warehouse has recently been built satisfying the most modern requirements, and provision is made for the custom-house operations. The building has several floors, and the cellarage, the ground floor and the upper floors are all arranged for storage purposes. Electric lifts are provided for conveying the goods.

At *Fiume* (see general plan, figure 33) there are a larger number of places for storing goods, most of them being old wooden goods sheds at ground-level and let to private parties. The goods are taken on hand-carts from the sheds to the cars; in some cases hand-operated wall cranes and travelling cranes are available. These old wooden goods sheds are gradually being pulled down and replaced by warehouses with several floors; some of these are built of reinforced concrete, others of brick.

The first larger-sized warehouse of this kind was built at the Molo Marie Valerie; it has three floors, and its dimensions and chief particulars are shown in figures 39 to 42. The railway lines run into the ground floor, and wall cranes and electric hoists are used for conveying the goods up and down. Originally shoots in the form of inclined planes were used for lowering bags; but these occupied much room and gave unsatisfactory results, and were quite recently replaced by vertical helical bag shoots, on the R. W. Dinenthal Company system, which are constructed either by that company or by the Budapest Pumpen and Maschinenfabrik Company. The helical surface as well as the wall lining consist of iron plate, and the bags as they descend can be caught and sorted on any of the floors. Large electric gantry cranes are provided for transferring goods from the warehouse to ships or vice versa.

The arrangement of the other new warehouses at Fiume, Nos. II, III*a* and III*b* is shown in figures 39 to 45. In addition to hand-operated wall cranes there are everywhere electric lifts, the shafts of which are made of reinforced concrete; these lifts are designed for a load of 1,500 kilograms (3,300 lb.) and a rate of 35 centimetres (1 ft. 1 $^{13}/_{16}$ in.) per second.

The iron lift cages are each hung from

two steel-wire ropes, which are always loaded uniformly, and are not supported from the shaft walls, but from a separate iron structure. The doors to the lift only open, if the lift has already stopped behind them, and close automatically as soon as the cage moves. This automatic action can however be stopped by means of a handle, so that the cage passes at points where no loading work is done, and the doors do not open.

The lifts can be operated at every loading point; but hand wheels or cranks are also provided, to make it possible to operate the lifts by hand, should the current fail.

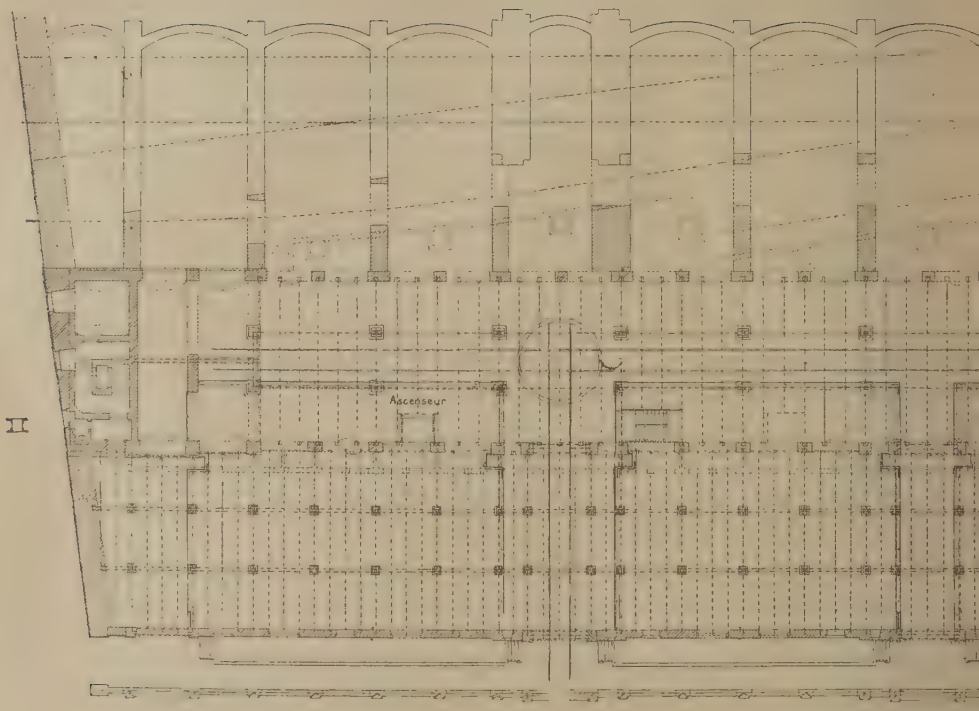


Fig. 34. — Brünn sta

Explanatio

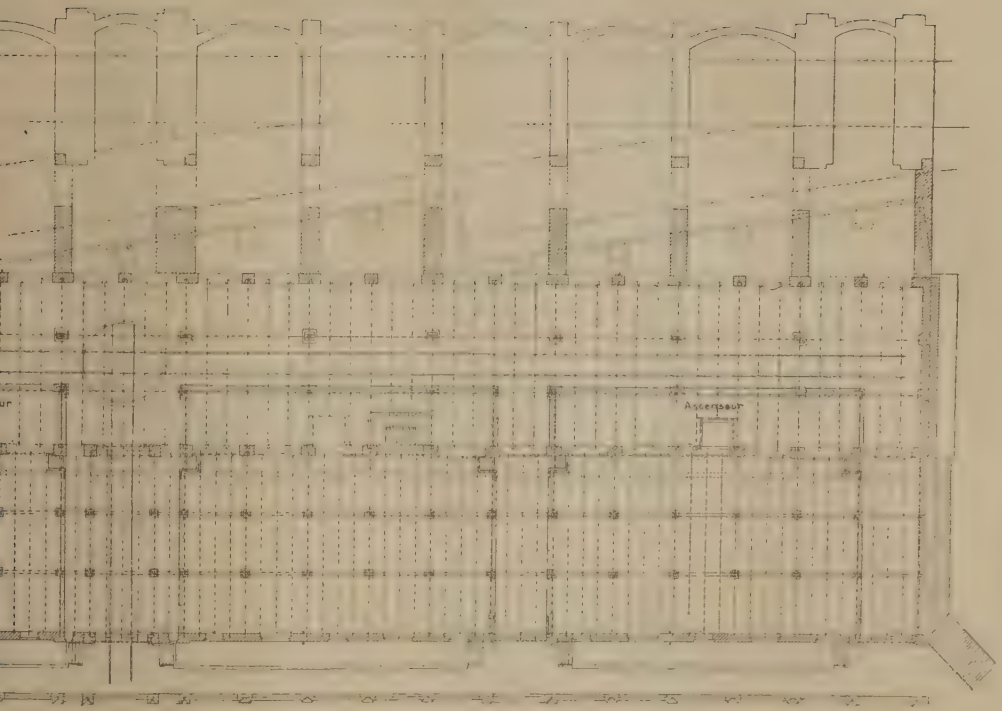
CONCLUSIONS.

When a new large station is to be built, or an old one is to be rearranged, the following rules should be observed :

1° The passenger traffic and the goods traffic should be kept separate, not only within the large station itself, but also if possible between that station and the neighbouring stations;

2° The passenger station should be located as near to the centre of the town as possible; and if the town is a large one, several stations connected by a through line should be constructed;

3° If the town is to have one central station only, a sorting station should be provided near the station proper; and if the latter is in the middle of the town, the tracks should be either above or below



— Plan of ground-floor.

ıseur = Lift.

street-level. If there are to be several passenger stations, it is advisable to provide, at each of two opposite points of the boundary of the town, an auxiliary station which can be used for passenger traffic as well as for sorting and marshalling trains. The passenger stations located inside a town should be through stations and the lines connecting them should be above or below street-level;

4° The installations for the quick-freight and mail traffic should be as close as possible to the passenger station; if there are several passenger stations, these installations should be at the auxiliary stations, in the immediate neighbourhood of the receiving office;

5° The short-distance traffic and the long-distance traffic should be kept separate at all those stations where there is a considerable amount of short-distance traffic; the best way of doing this is to provide special sets of tracks, and if this is not possible, to provide individual tracks for the short-distance traffic. In the latter case, it is advisable to have the tracks for

Fig. 35. — Plan of first floor.

Explanation of French term : Ascenseur = Lift.

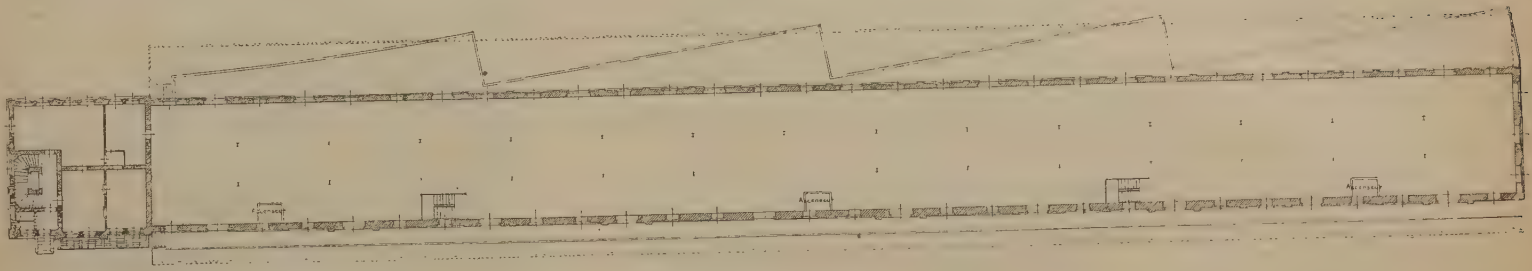


Fig. 36. — Plan at rail-level.

Figs. 35 and 36. — Brünn station. — Goods shed.

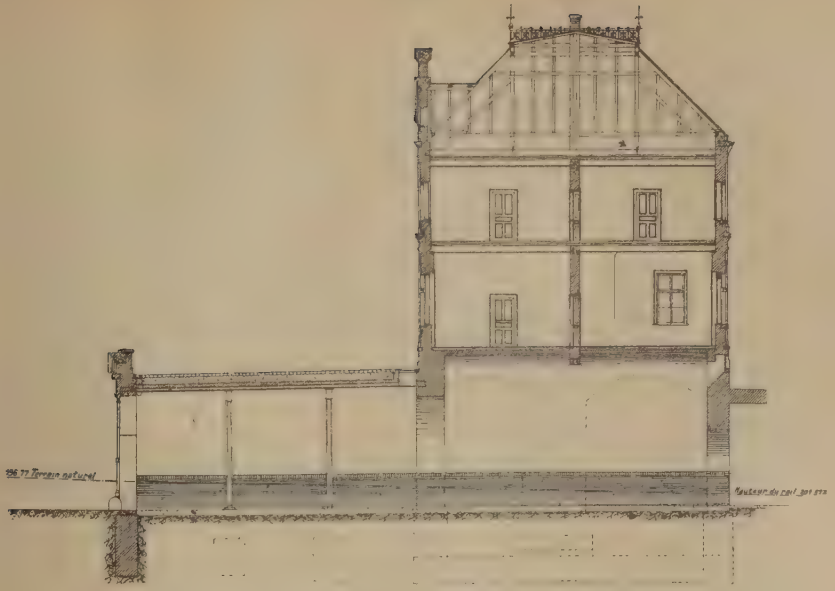


Fig. 37. — Section A-B.

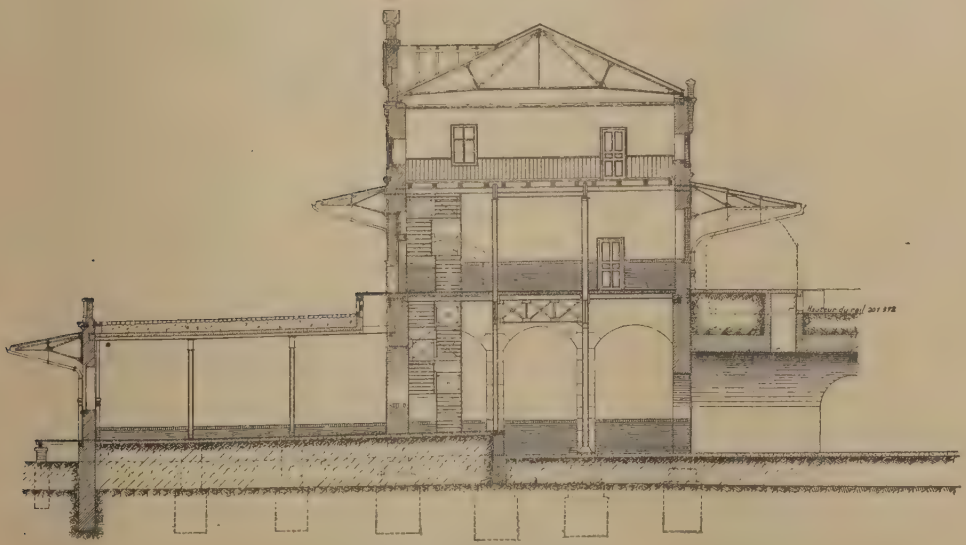


Fig. 38. — Section C-D.

Figs. 37 and 38. — Brünn station. — Goods shed.

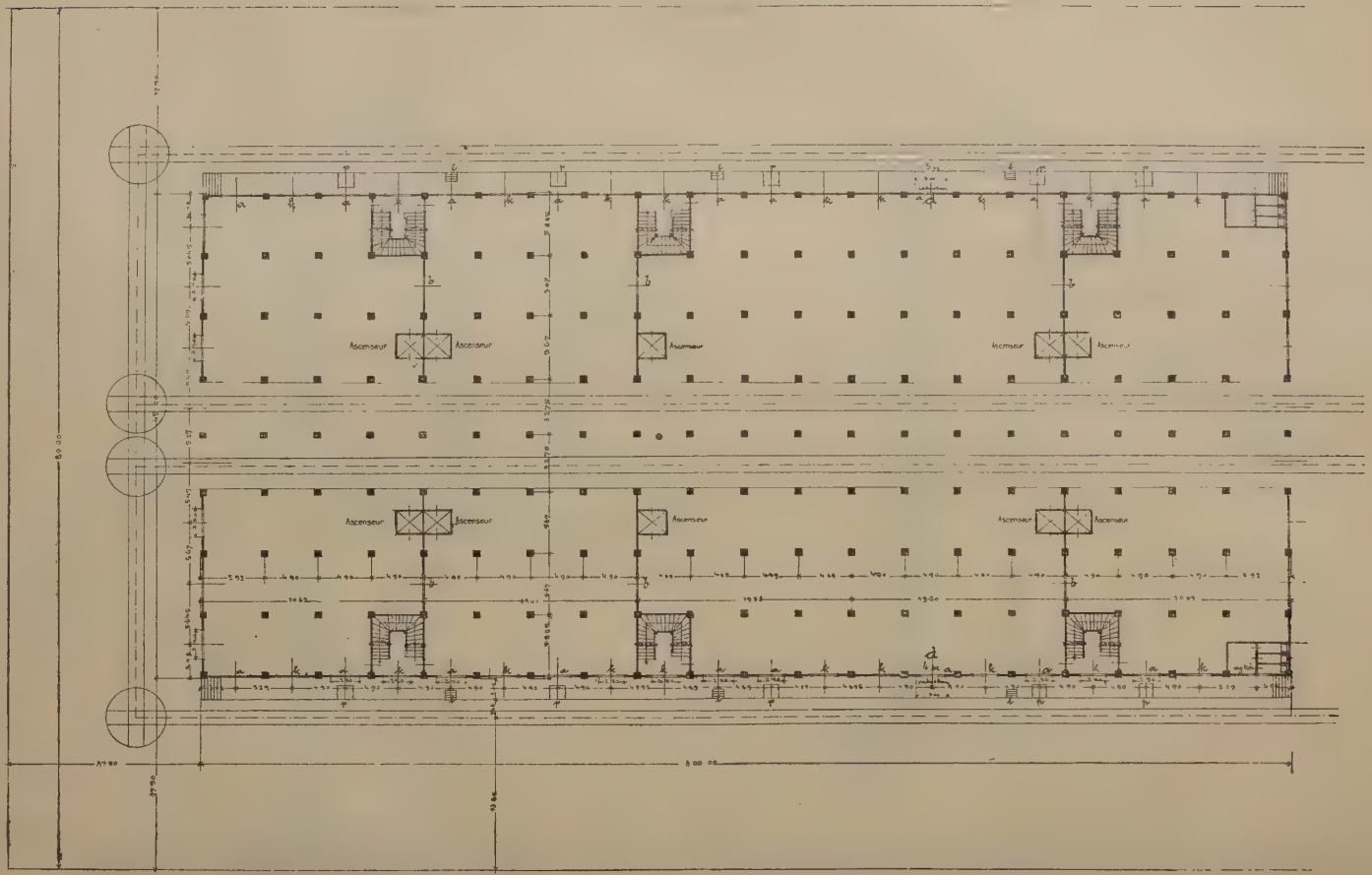


Fig. 39. — Hungarian State Railway. — Goods shed, Marie-Valerie jetty, Fiume.

Explanation of French term : Ascenseur = Lift.

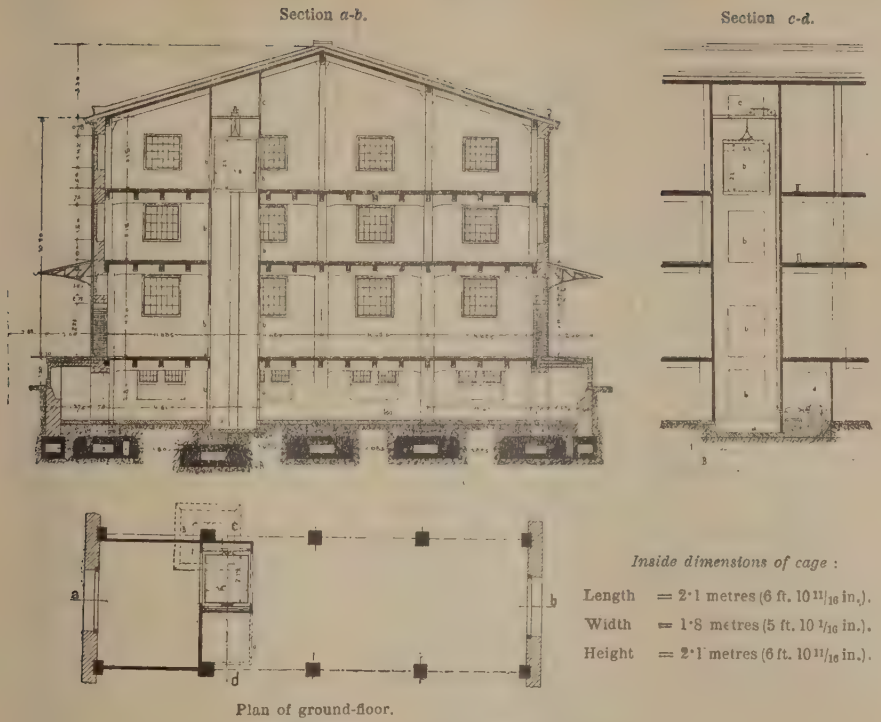

Section a-b.
Section c-d.
a
b
d
Plan of ground-floor.
Inside dimensions of cage :
Length = 2·1 metres (6 ft. 10 11/16 in.).
Width = 1·8 metres (5 ft. 10 1/16 in.).
Height = 2·1 metres (6 ft. 10 11/16 in.).

Fig. 40. — Hungarian State Railway. — Goods shed, at Fiume.
Electric lifts to carry 1,500 kilograms (3,300 lb.).

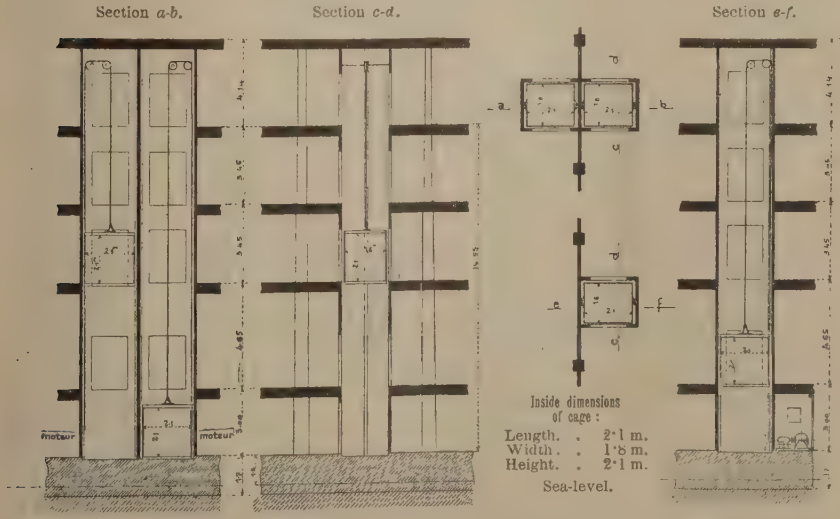


Fig. 41. — Hungarian State Railway. — Goods shed at the Marie-Valerie jetty at Fiume.
Electric lifts to carry 2,000 kilograms (4,400 lb.).

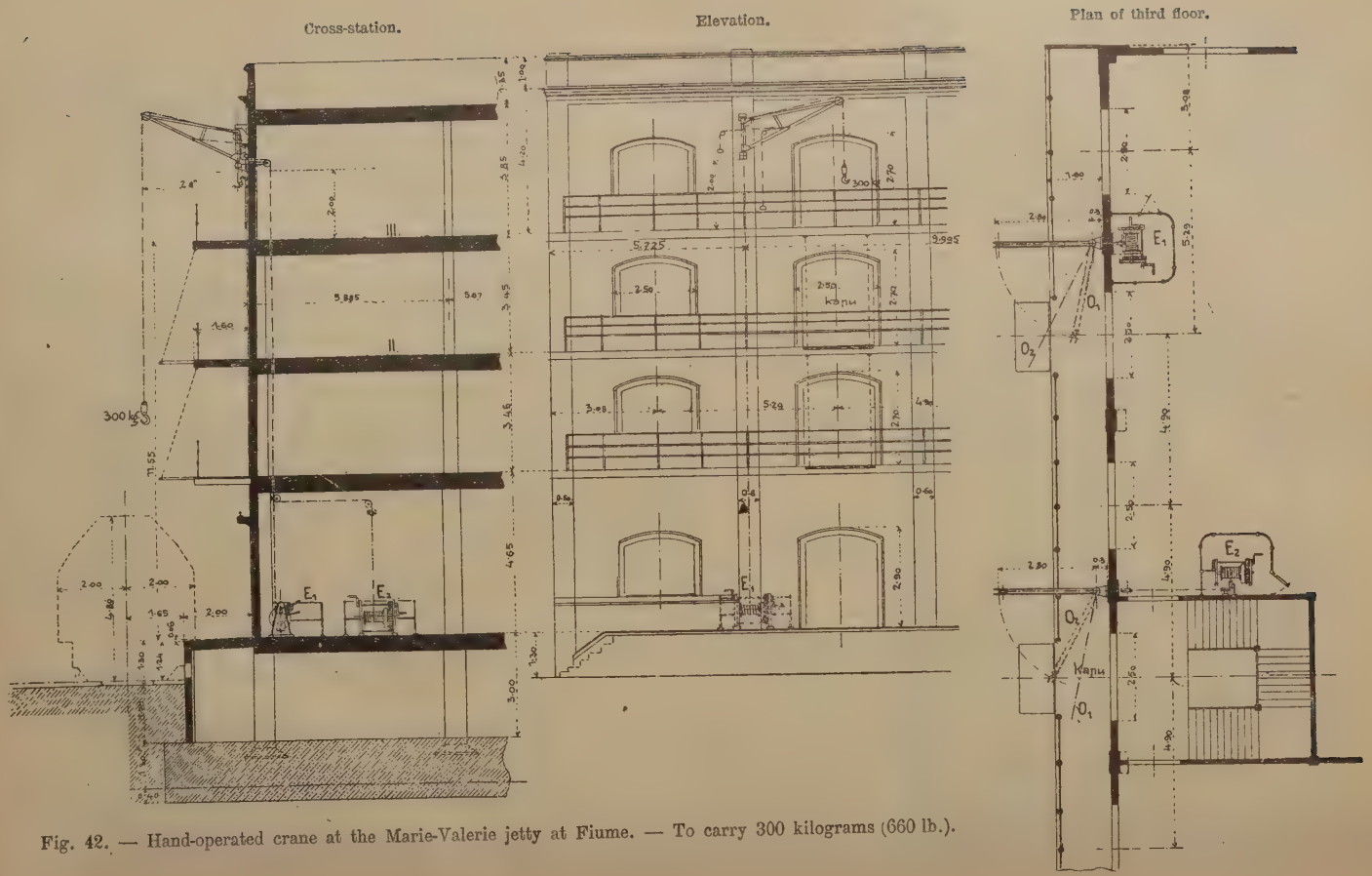
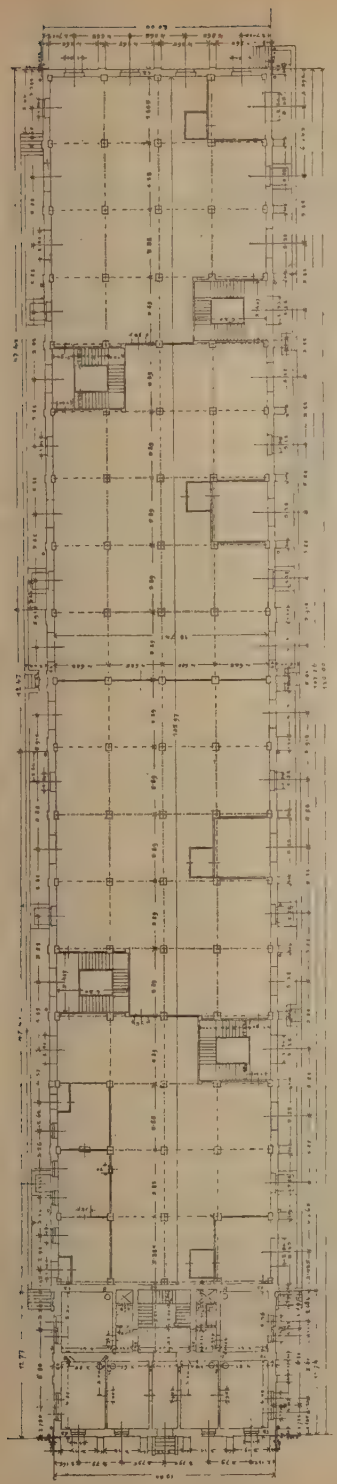


Fig. 42. — Hand-operated crane at the Marie-Valerie jetty at Fiume. — To carry 300 kilograms (660 lb.).



Plan of ground-floor.

Fig. 43. — Hungarian State Railway. — Goods shed at Fiume.

the short-distance trains next to platforms connected at right angles by a central platform;

6° It is also useful to place loops behind the passenger or auxiliary stations, so that the local trains which have arrived can be made ready to start again in the opposite direction in the shortest time possible;

7° The sorting station should be placed as far as possible between the main running lines, so that the trains running between the passenger station and the sorting station do not have to cross these lines. If overbridges or underbridges are however used, other arrangements can also be conveniently adopted;

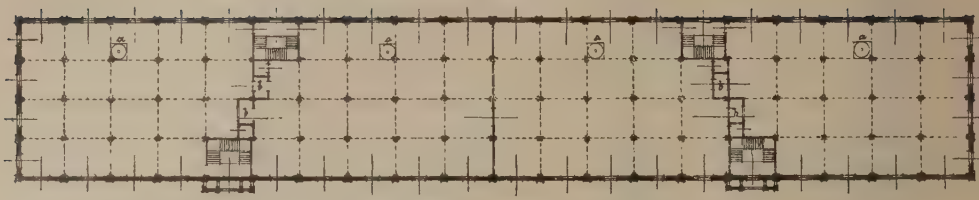
8° The changing of locomotives, at terminus stations, by means of turntables and traversers, is to avoided; switches are perferable, but the loop arrangement mentioned above is better still. At through stations separate readily-accessible tracks should be kept clear for changing the locomotives. The locomotive sheds should be as near to the station as possible, and where there is a sorting station, they should be in close connexion with the latter;

9° The addition and the removal of vehicles is best effected by means of dead-ended sidings located at the ends of the platforms. The marshalling of the trains, and the cleaning and the equipment of the carriages are best effected near the departure side, while trains can also be stored near the arrival side;

10° It is incontestably advantageous, in large towns, to have stations with the tracks above or below street-level. At such stations, the ticket offices, the offices for receiving and delivering luggage, the book and other stalls and the staff rooms should be on the ground floor, while the waiting and refreshment rooms and offices should be at track level;

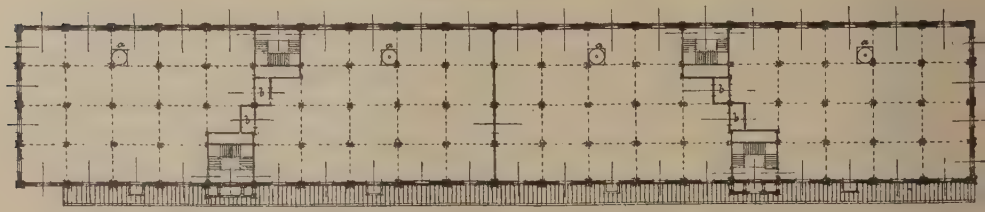
11° At stations which are at street-level, hand trucks suffice for dealing with the luggage, while hydraulic or electric lifts seem desirable

General plan of 2nd and 3rd floor.

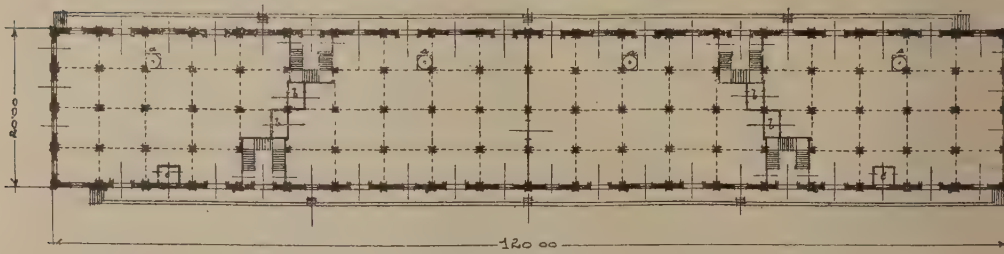


a = Sack shoot. — *b* = Lift. — *c* = Office.

General plan of 1st floor.



General plan of ground-floor. Side facing sea.

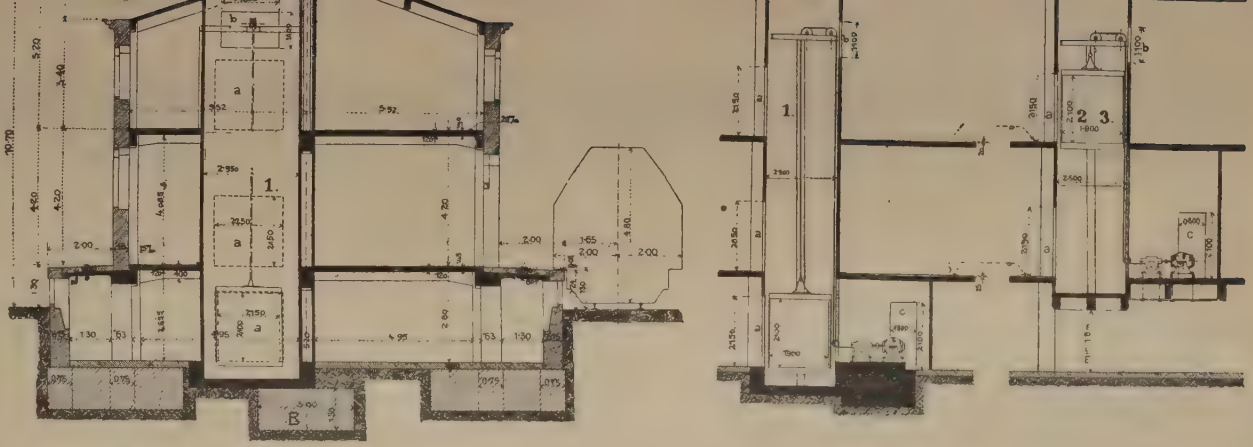


Side facing town.

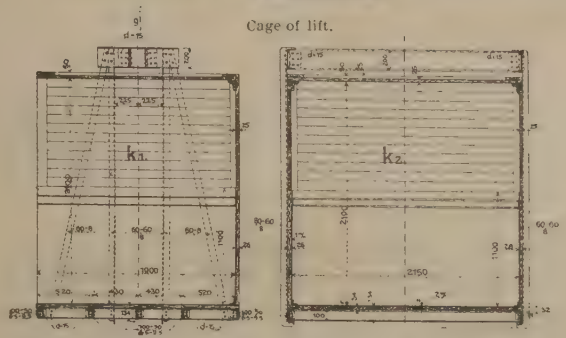
Fig. 44. — Hungarian State Railway. — Goods shed No. II at Fiume.

for raising and lowering the luggage at stations with several floors. The passengers should be given access to the island platforms by means of wide subways and convenient staircases, and if possible a separate subway should be provided as way out. If there is very much traffic, it is also advisable to have separate " way in " subways, for passengers of the first and second classes, and for passengers of the third class;

12° The goods yard can be built in an outer part of the town, but not too far from the commercial and industrial centres; it should be connected, by a suitable number of tracks, with the sorting and shunting yard which should be located in its neighbourhood;



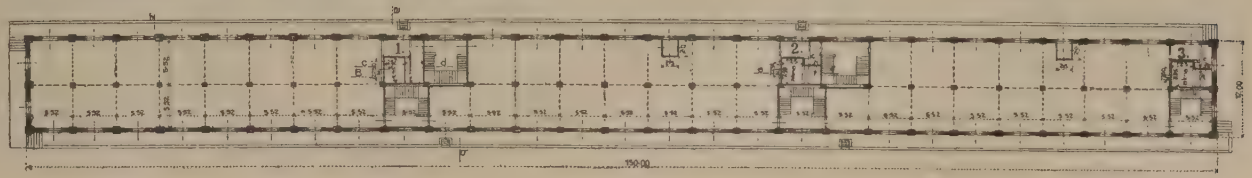
Cage of lift.



Inside dimensions of cage

Length	= 2·15 metres (7 ft. 5/8 in.
Width	= 1·90 metres (6 ft. 2 13/16 in.).
Height	= 2·10 metres (6 ft. 10 11/16 in.).

Side facing sea.



Plan of ground-floor.

Side facing tracks

Fig. 45.— Hungarian State Railway. — Electric lifts of goods shed No. III*a* at Fiume.
To carry 1,500 kilograms (3,300 lb.)

13° The sorting and shunting yard should be on a continuous incline, if the ground has a suitable slope for this purpose; if not, the use of saddle-backs will suffice. In order that the wagons should have continuity of movement during the shunting operations, the reception, the sorting, the marshalling and the departure sidings, should follow each other in regular order; moreover it is advisable to locate the whole sorting and shunting yard on both sides of the running lines in such a way, that the sorting for each direction is wholly carried out on the one side;

14° If the whole shunting and sorting yard is only on one side of the lines, the entrance and departure tracks should be as far as possible be placed above or below the running lines, so as to avoid the crossing of the latter;

15° Special sets of sidings for geographical sorting are advisable, if the number of wagons which have to be arranged according to station is considerable;

16° Moving wagons can be conveniently stopped by means of rail brakes and skids;

17° In single-floor goods sheds, wall slewing cranes and travelling cranes as well as capstans will suffice, while in the case of buildings with several floors, portal cranes and lifts can also be used with advantage.

SECTIONAL DISCUSSION

Meeting held on 5 July 1910 (morning).

MR. DIETLER, IN THE CHAIR.

The President. (In French.) — I call upon Mr. Jaggard, reporter for America, to explain the conclusions of his report.

Mr. Jaggard, *reporter.* — My report is divided into three parts : *a*) arrangements at the stations, measures taken for improving the service and increasing the safety, stations with separate floors in order to utilize the space in large towns better; *b*) arrangements for obtaining continuity of movement in shunting operations; *c*) baggage service, subways.

The conclusions I draw from my paper are as follows :

A. — Special arrangements calculated to increase the capacity of stations and safety of operation have been adopted in accordance with the needs of the different sections of the country. In some instances needs for fifty years ahead have been anticipated. The principle of separation of the various classes of traffic is observed to have application everywhere. In the older stations the separation of through from suburban traffic and the handling of baggage, mail and express in such manner as not to delay train movement and station operation is only accomplished by great ingenuity and the use of various make-shifts. On the other hand, the newer stations show most complete arrangements for radical separation and individual development of the various functions. In doing this, the loop is shown in only a few cases, but its more extensive use is indicated.

Excellent arrangements have been made and adequate facilities provided for all varieties of station work, including the cleaning and inspection of coaches, the making up of trains, their rapid movement into the stations, changing locomotives and coaches. Safety has been secured by the installation of proper interlocking, signal lay-outs and by a separation of lines and grades. Distinct progress and development in all of these features has been shown since the seventh meeting of the International Railway Congress in Washington.

A number of stations have been built in which the tracks are on different levels. The tendency is shown toward the adoption of this type of station. The offices are distributed between the floors according to space and utility. The adoption of separate floors has resulted,

*

from the requirements in large cities that grade crossings be eliminated, as well as by typographical conditions, value of real estate and other considerations. The more obvious advantages which result are: the consultation of public taste and comfort; more compact working, and in some instances a relative economy in operation.

Comparatively little has been done in the way of the adoption of new arrangements of platforms taking the country over. The same may be said of the adoption of new types of passenger cars, especially adapted for quick unloading.

The appliances for the conveyance of luggage show a development from the two-wheel and four-wheel truck to the electric automobile. Horizontal moving platforms are also contemplated.

For the conveyance of passengers progress is shown in the adoption to a limited extent of moving stairways. Electric and hydraulic elevators, however, are the devices usually found.

B. — All the recent designs show that effort is made to secure continuity of movement through the various yards. Heavy expenditures are made to attain this result. Without securing it by one means or another, it would be impossible to handle the traffic. The general method in vogue is to pass the cars over a hump standing between the receiving and classification yards. In well-designed yards nine-tenths of the cars pass through from one end to the other without a reversal of their movement. Exceptions are due to local conditions. Distant departure yards are used in the modern yards. The typical American yard group as now developed consists, therefore, of a receiving, a classification and a departure yard connected by humps or by natural grades, such a group being provided for movement in each direction. In a few of the larger yards the number of cars handled in twenty-four hours is as high as ten thousand.

The arrangement for handling cripple cars is usually to assign a track or tracks in the classification yard to which they run from the hump. Speaking generally, the relatively small volume of preference freight, high-class freight and local freight to be handled has not as yet necessitated separate facilities, but these classes of freight are usually passed along with the mineral and coarse freight over the same hump, the high-class freight being then handled on specially assigned tracks in the classification yard or in small pocket yards. Probably a more distinct separation will be brought about in the next few years, due to a variety of causes, among which are the necessity of moving high-class freight at nearly passenger speed and, therefore, on passenger tracks, the increased volume of high-class traffic, the separation of slow freight routes from passenger and high-class freight routes, the necessity for feeding and handling stock, icing perishable commodities, inspection, and diversion privilege.

To stop and start the cars, hand-brakes are depended upon. A few yards show derailing switches to stop run-away cars. Skids and other devices are used in exceptional cases.

C. — The appliances in common use are the two-wheel and four-wheel trucks; also special trucks for pianos, safes and heavy articles.

For high capacity trucks, fixed jib cranes and overhead cranes of various types are used. In storage warehouses horizontal conveyors are coming into use, as well as overhead travelling cranes.

A number of special devices designed to effect a distinct improvement in the quickness and cheapness of handling package freight have been considered. Many different arrangements have been worked out on paper but little practical result has been attained. The future is thought to hold many undeveloped possibilities in this line. The most radical step so far taken is the handling of package freight in the Chicago system of underground tunnels.

With the building of larger freight stations many improvements in design and arrangement of space have been accomplished. The subject is receiving much closer attention on the part of railways than obtained in former years.

The President. (In French.) — I call upon Mr. Jullien, reporter for all countries except America, Russia, Austria, Hungary, Rumania, Bulgaria, Servia and Turkey.

Mr. Jullien, *reporter.* (In French.) — Question IX, large stations, includes two separate parts :

The first, littera *A*, concerns large passenger stations ;

The second, littera *B*, concerns large goods stations.

My colleague, Mr. Leverve, will deal with this second part.

Littera *A* of the question is worded as follows :

Best arrangement of tracks, so as to increase their working capacity and ensure safety in shunting operations. Improved mechanical appliances for the conveyance of luggage, etc.

We drew up a detailed list of questions about this subject and sent it to the railway administrations concerned; we received thirty-three answers from the following countries :

South Africa, Germany, England, Australia, Belgium, India, France, Holland and Switzerland.

As was to be expected, the stations of which we received plans and about which we received information show great differences. On examining them however, one finds that in such large stations there is a tendency to adopt certain general principles which we will now enumerate :

The different tracks are as a rule not specially devoted to the reception or the dispatch of trains running in a given direction. In this way, the working capacity of installations of equal magnitude is increased. This common use of the trains is made possible by having large scissors crossings at each end of the station, connecting all the different tracks. In order to increase the working capacity of such stations still further, power signalling and switching arrangements are being used more and more instead of apparatus operated by hand, the power being supplied either by water under pressure, or by compressed air, or by electricity. Such power installations make it possible to operate the apparatus more quickly, and make it easier for the signalman, who no longer has to use his strength, to concentrate his attention on the operations which have to be carried out.

There is, however, a tendency to keep the suburban tracks separate from the main-line tracks, particularly when those suburban tracks can be placed at a different level from the main-lines; thus it is proposed to do this in Paris, at Saint-Lazare station.

This differentiation between the suburban services and the main-line services originates from a wider principle, which seems to be being adopted more generally, and which consists in keeping separate, as far as possible, the passenger service, and the parcels service, the mail service and the local slow-freight service. Thus all the space available is reserved for the passenger station proper, which is generally located in places where the purchase of land, in order to enlarge the station, is a very difficult and costly matter.

Acting from the same point of view, the marshalling sidings and the locomotive sheds are being removed more and more from passenger stations. These marshalling sidings as well as the sheds are then connected, as far as possible, with the station tracks by means of a double track used only for the shunting operations of locomotives or of sets of carriages used for making up trains.

At large stations, level crossings across the tracks, for use by the passengers, are generally avoided. As a rule, sub-ways are constructed for the purpose, except in the case of a terminus station where the different platforms are directly accessible from the main cross platform. It is for this reason often advisable, whenever local conditions make it possible, to have a station with floors, that is to say to place the passenger tracks either above or below the level of the station entrance and the booking office. In this way, the passengers are saved a useless ascent or descent. This arrangement also makes it possible to cross the streets of a town either above or below. Finally, this scheme generally makes it possible to effect important economies in the purchase of land. It is true that it becomes necessary to instal mechanical devices for lifting or lowering the luggage the height corresponding to the difference of level between the public roads and the railway. Electric or hydraulic lifts are very generally used for this purpose. These, like all appliances with reciprocating movements, have the disadvantage of giving only an intermittent and consequently rather limited output. This disadvantage does not make itself felt so much in the case of departing luggage, which arrives at the station at different times, so that enough time is available for dealing with it. But the same does not apply to arriving luggage, which comes all by the same train and nevertheless should be quickly delivered to the passengers. At several stations this has led, for instance at Paris (Quai d'Orsay and Invalides stations) and at Hamburg, to the installation of endless belts, which give a much quicker service. We will say several words about this point, when we deal with mechanical appliances.

What I have just said about stations with different floors cannot be applied without reservation to the English stations, where the luggage service is quite different from what it is in the other countries of Europe, and where it is recognized that cabs, etc., must have access to the arrival platforms, so that passengers after leaving the train can at once take them without going out of the

station. In such cases, a station with floors may lose part of its advantages.

Finally, I will say a few words about the mechanical appliances used for the conveyance of passengers, luggage and parcels.

Lifts are too well known to make it of interest to mention them.

The conveyance of luggage by travelling endless belts, such as have been installed by the Orleans Railway at Quai d'Orsay station, is however worthy of some mention. Horizontal belts, placed below the main-line arrival platforms, receive the luggage through openings arranged in the platforms, and take it to inclined belts, which raise it to the first floor and tilt it on to a sorting table. The following rule has been adopted for arranging the luggage on the delivery tables. Above the tables are placards shoving the figures 0, 1, 2, ... 9. All the packages the registered number of which ends with the same figure are placed on the table below the placard bearing that figure; and as the registered number is given on the luggage ticket which the passenger received when he registered his luggage, he knows at once, by looking at his luggage ticket, where he has to look for his luggage. The packages as they arrive at the sorting table are there taken by porters who direct it to the right or to the left, according to the last figure of the registration number. The packages thus arrive on a movable table which carries them horizontally in front of the receiving table. In the space between the movable table and the receiving table there are porters, at each placard, who remove the luggage corresponding to a given figure and place it below the placard bearing that figure. The packages, as soon as they have been identified by the passengers, are then placed on the delivery tables, at their disposition. In order to facilitate the handling, the delivery table is a little lower than the sorting table, and this is again a little lower than the movable table.

When this system is adopted the delivery of the luggage is effected very much more quickly than with the ordinary system of loading the luggage on to a truck, running it to the delivery tables, and unloading it there. One may say that the time required for the operation only depends on the quickness with which the luggage can be unloaded from the van on to the platform.

Similarly, at the Quai d'Orsay station the time required for the passengers to leave the station has been materially reduced by placing at their disposal a moving staircase. This staircase may be considered as formed by an endless chain going roud two drums, the one at the top being the driving drum, and the other being at the bottom. The links of this chain are formed by the steps which are separated by empty spaces of a width equal to that of the steps. The two upper and lower landing-places are formed by a kind of comb, through which the steps can pass during their movement of rotation.

The rate of movement of the passengers has been more than doubled by the use of this moving staircase.

Finally, I will conclude this summary by a short description of the mechanical sorting of the parcels at Paris-Austerlitz station. This sorting is only carried out as regards the parcels dispatched from that station, amounting on the average to

30,000 per day, of which about 20,000 are sent grouped, either as complete van loads to large stations, or packed into baskets, either to the stations of sufficient importance or to groups of smaller stations. The number of baskets dispatched each day from Paris-Austerlitz station averages about 900.

Nearly all the parcels use the evening train and are handed in by the consignors between 6 and 8 p. m.

The parcels, according to their labels, are marked with chalk, with one of the figures 0, 1, 2, 3 or 4, and are thrown into one of the openings in the platforms.

The figures 1, 2, 3 and 4 are used for the baskets only, and the figure 0 for full van loads.

An endless belt takes the parcels belonging to the first class side of the basket service, to a sorting table, where, in accordance with the figure marked on them, they are transferred by sorting porters to the belt corresponding to the figure with which they are marked. They are thus taken to a store-room bearing the corresponding figure. A first sorting operation by direction is thus effected.

When the time has come for getting ready a train corresponding to a given direction, the store-room in question is opened and the parcels contained in it are placed on to an endless belt passing along the bottom of it. The parcels are thus taken to a second sorting table, where there are seven inclined shoots to the reception tables.

Employees well acquainted with the railway system are placed at the sorting table for directing the parcels into the corresponding shoot; others are placed at the reception tables. The latter place them into the baskets corresponding to the different stations or different groups of stations of the section.

The packages which are marked with the figure 0 and are hence intended for full van-loads, only go through one sorting operation. They are directed into special store-rooms, six in number, each corresponding to one large station on the railway system. There they are placed into six special shoots and pass into the vans, under the action of gravity.

I have now completed the summary of that part of our report which refers to the passenger service, and I have the honour of proposing the following conclusions:

The preceding information leads us to conclude, as regards large passenger stations that in order to obtain the maximum working capacity, combined with safety of working, it is advisable in the first place to divert from them everything connected with the local goods and parcels services. It is equally advisable to concentrate the suburban service on certain tracks which are in principle reserved for it; but to utilize at certain hours or on certain days, where one of the two traffics, suburban or main line, becomes of preponderating importance, either the main lines for the suburban service, or the suburban lines for the main-line service. The establishment of large scissors crossings at the entrance of stations which makes it possible to receive a train coming from any direction on any of the tracks tends to become general and seems to be an excellent means for increasing the working capacity. The use of power-operated signals and switches, which can be set easily and quickly, and the use of which tends to become general, makes it possible to utilize these connections under the best conditions. It is, finally, an advantage to have in front of the different platforms tracks making it possible to change locomotives

quickly or to alter composition of trains quickly. A set of marshalling sidings near the station, and connected with it by independent tracks, is also a very useful addition to the installation.

When the local conditions allow it, it is as a rule of advantage to adopt either the type of a station with floors, or the type of mixed station, that is to say including tracks at two different levels. The ground is then utilized better, the passengers can be more easily distributed among the various platforms, and the luggage service can be carried out with much less inconvenience to the passengers.

The use of mechanical appliances for handling the luggage is much to be recommended, and, at stations with floors, the use of elevators to save the public the mounting of stairs, appears to be an important improvement, particularly when those elevators are of the continuous-action type.

It has to be added that it is rather exceptional to have to build a whole new large passenger station. It is much more usual to have to modify or enlarge an existing station; one is then hindered by local difficulties from applying the principles we have expounded, except to a limited extent. (*Applause.*)

The President. (In French.) — I now call on Mr. Leverve, the second French reporter on question IX.

Mr. Leverve, *reporter.* (In French.) — The second part of the question relating to large stations was worded as follows :

Large goods stations :

1° *Arrangements of tracks :* a) *to allow the continuity of movement of vehicles which require shunting and which are separate from the time the train bringing them has arrived until the train taking them away is being made up ;* b) *to prevent such movement from being interfered with by the arrival or departure of trains ;* c) *to stop without shock such separate vehicles at the end of the successive movements required ;* d) *to start them off again.*

2° *New appliances for handling goods.*

As the installations of goods yards depend on the requirements of the public, the nature of the local traffic and the topographical conditions resulting from their position in the towns, these yards naturally show great variety. It is hence hardly possible to draw any general conclusions as to how the sidings are arranged.

The same is not the case with sorting yards, which are yards used purely by the railway and to which the public has no access; these yards are used solely for making up and taking apart goods trains and for transhipping goods. Such yards can accordingly be constructed, and now frequently are constructed, in the open country and designed to suit as far as possible the corresponding traffic.

The plans and the information we have received from the different railway administrations in answer to our list of questions relating to their sorting and shunting yards, show that these yards show a general arrangement of which I will give a brief summary, mentioning the principles which seem to be involved.

In sorting and shunting yards of recent construction, attempts have been made to ensure the continuity of the movement of the cars which have to be dealt with, from the time an arriving train is received until a train is made up and ready to leave, so as to avoid any useless movements involving loss of time and extra shunting operations.

With this object in view, the sidings are as a rule arranged in three large sets over which the wagons which are being sorted pass from their entry into the station to their egress :

The reception sidings on which the trains to be sorted are received immediately on arrival, in order to await sorting operations. The number of these sidings depends on the number of trains which have to be received during the maximum length of that period of waiting. From all these sidings, the trains pass to a central set of sidings used for sorting;

The central set of sidings includes a number of sidings varying with the number and the importance of the lines terminating at the yard and of the sorting which has to be effected;

Finally, there are the departure sidings where the made-up trains wait till they have to start.

Moreover, the geographical classification of trains formed of several sections and in particular of pick-up goods trains can be effected either on a special set of sidings, similar to the others, but of much shorter length, or on one or more gridirons placed between the main sorting sidings and the departure sidings.

At many yards however these supplementary sidings or gridirons do not exist and the main set of sorting sidings is used itself for making up the trains, the geographical classification being effected on the ends of the sidings near the departure sidings, one or two lateral hauling lines being added to the departure set. In such cases the main sorting sidings as such receive a rather greater length.

The solution to be adopted from this point of view must evidently vary with the importance of the sorting yards and with the amount of geographical classification which has to be carried out, and also with the greater or lesser difficulties which may arise, in consequence of local conditions, in the construction of the sets of sidings.

At large sorting yards particular care is taken that the reception of the trains at the reception sidings and their dispatch at the departure sidings as well as the different movements of the locomotives should either not interrupt, or interrupt as little as possible the operations of sorting and of making up the trains. It is evidently of economic interest to carry out the work quickly as this involves both a reduction in working expenses as well as a reduction in the time during which the goods and the rolling stock are staying at the station. With this object in view, extra lines are laid passing round the other sidings and many junctions are made between the tracks of the latter, so as to make all the movements as independent as possible of each other.

The arrangements described exist in a more or less complete form at most of the large sorting yards about which we have received information, especially in France at Lumes (near Mézières), Saint-Pierre-des-Corps (Tours), Juvisy; and in Germany at Mannheim, Nuremberg and Dresden.

But it is important not to forget that to carry them out in full is a very expensive matter; such sorting yards become very large. Thus Lumes covers 50 hectares (123·5 acres), Nuremberg 100 hectares (247 acres) and Mannheim more than 200 hectares (494 acres); the installations must accordingly be more or less of a size

suited to the importance of the sorting operations which have to be carried out. An installation which would be justifiable at a station where the sorting operations are of considerable importance, would if adopted at a station of less importance involve an excessive capital outlay and even, if not proportioned to the work to be done, excessive working expenses for a service which would still be defective on account of its slowness.

The wagons are moved on the different sidings by being pushed up on to a saddle-back, or by having the tracks arranged on a continuous incline from one end of the yard to the other.

In the former system, which is that generally adopted in France, and it seems also in the other countries, except England, the set of sorting sidings is commanded on the reception side by a saddle-back on to which the trains to be sorted are pushed. It may even be advantageous to have two saddle-backs, side by side, at different levels, utilized according to the atmospheric conditions which may exist. The descent of wagons on sorting sidings is often hampered by the influence of wind and of frost.

The sorting sidings are on the flat or on a gentle down-gradient in order to facilitate the descent and the coupling up of the sorted wagons.

When there is no special set for the geographical classification, the main sorting sidings which are used for this purpose also, must have another saddle-back at their other end.

The set of sidings for the geographical classification is as a rule also furnished with a saddle-back, less high than that of the sorting sidings.

The arrangement of sidings on a continuous incline exists at some English yards, for instance at Edge Hill, also at yards on the French Northern Railway and at certain German yards, for instance Nuremberg, Dresden, etc.

It seems to be more suitable for quick operations owing to their simplicity and their constant direction from one end of the yard to the other, and it has the advantage of a considerable reduction in the cost of shunting operations of locomotives, which results in a considerable saving in working expenses. But this system is not very realizable in practice unless topographical conditions are specially favourable, and that is no doubt rather an exception.

The wagons are stopped, without shock, at the end of their different movements, either by means of their own brakes in the countries like England, where most of the wagons are equipped with hand brakes, or by means of skids, now very extensively used.

The latter, when well applied by the employee in charge, make it possible to stop, without shock, the wagon at a short distance from the others it is to join; it then moves this short distance down the gentle incline after the skid has been removed.

The rail-brake (*Gleisbremse*) is rather extensively used in Germany. It is placed a little below the top of the saddle-back and its travel is limited by a special device which throws the rail-brake off while the wagon it has checked continues its journey. It makes it possible to regulate the movement of the wagons, which is influenced by their load and by the existing atmospheric conditions.

The action of this rail-brake accordingly facilitates the work, but its use involves extra labour to start with, and is only possible when the saddle-back and the head of the sidings are sufficiently far apart.

The mechanical handling of wagons and of goods at the yards is becoming progressively developed.

The use of electric capstans and cranes for wagons is tending to replace manual labour and operations which take longer and cost more to carry out by means of horses or even engines. Certain stations have lines at different levels. The wagons are for instance loaded at a place which is at the same level as the adjoining streets, and then raised by lifts to another level, where the trains are made up.

In order to handle heavy goods in the yards or inside covered premises, hand cranes or electric cranes are used, as well as travelling cranes. These appliances have made it possible to have warehouses on different floors, such as are now found at certain stations, notably on those of the Orleans Railway, at Paris-Ivry and at Bordeaux, and also at a number of English stations. It is to be noted that in order to facilitate the mechanical handling of goods, English covered wagons are made with a top to open.

This special device does not exist in France.

At dock stations steam, hydraulic and electric cranes have for a long time been in use for transferring goods from a ship to a wagon or vice versa.

In this connection, it seems to us of interest to give a short description of the proposed installation at Bordeaux, on the right bank of the Garonne, for transferring coal, phosphates and minerals between the port and the Bastide station, which belongs to the Orleans Railway.

The operations of unloading these goods and taking them to the station are at present carried out as follows : the empty wagons are taken by a locomotive from the station to tracks parallel to the dock. They are then taken by hand, by means of turntables, to small tracks laid fanwise near the piers. There they are loaded up by means of steam cranes taking the coal out of the vessels laying alongside. The loaded wagons are then taken back to the station by a similar series of operations conducted in an inverse order.

In the proposed scheme, two landing-piers for ships will be used for the traffic in question. Each of them will be equipped with four electric cranes, together capable of unloading about 200 tons per hour, which by means of good grabs will take the coal out of the ships alongside the piers and discharge it into a vast hopper.

An electric suspended railway built along the pier, 1,200 metres (1,312 yards) in length, will convey the coal from that hopper to the place where the wagons are loaded, which adjoins the station. This railway will be double and its upper part will include rope hauling cages capable of conveying 200 tons per hour. The cages will become filled as they pass the hopper, and will convey the coal in a continuous manner to the loading place in the station. The hopper will act as a regulating device, so as to equalize temporary variations in the outputs of the unloading cranes and the suspended railway.

On arrival at the loading place, the

cages will be unlocked automatically and discharge their contents into motor hoppers, moving parallel to the suspended railway, above two rows of wagons, so as to fill all of them in succession.

Moreover, a coal store will be established at the loading place in order to receive the fuel intended for the company's use. It will be equipped with a travelling crane making it possible to take the coal to the store and take it up again by means of grabs in order to load it automatically into wagons.

As I have already stated, the suspended railway will be double, the upper part being used for the cable operating the conveyance to the station, as already explained, and the lower part being equipped with automatic electric cages for taking coal to several industrial establishments, which will be connected up with the system.

The installation described will be able to deal with a considerable tonnage, and will effect a very material saving by substituting powerful electric cranes for the old steam cranes and by eliminating the use of wagons and the laborious operations in connection with them. Finally, the quick rate of unloading will result in a much better utilization of the landing-piers, to the advantage both of commerce and of local navigation.

I may add that these installations are justified by the importance of the tonnage of the goods in question : namely more than 1,200,000 tons of total traffic on the piers on the right bank of the Garonne, more than one third of which is fuel supplied to the Orleans Railway.

After these explanations, gentlemen, you will allow me to repeat to you the conclusions which we have the honour of proposing to you in our report :

Shunting yards can as a rule be built in the open country and constructed to suit the purpose they are intended for, without having their design influenced by local conditions foreign to the working conditions of lines which are to be provided for.

Such yards, it seems, should in all cases include three sets of sidings for : the standing after the entry, for the sorting and finally for the marshalling and standing before the start, of the trains to be dealt with. The length of those sidings depends on the length of the trains, and their number, on the density of the traffic.

When the yards have to provide for a very busy traffic, other sidings of less importance are added for the geographical sorting.

Finally, these can all be doubled, so as to have two distinct complete sets, one for the one direction and the other for the other.

It is a great advantage to arrange these different sets as well as the running lines, in such a way as to obtain a continuity of movement in the shunting operations and to eliminate any interruption of these operations owing to the arrival or departure of trains.

Shunting yards cannot practically be built with a continuous incline unless the ground has a natural slope; and in most cases it appears preferable to have saddle-backs. The skid seems to be the best appliance for stopping wagons.

The mechanical handling of the goods or wagons in the buildings and near the buildings, by means of hand cranes or electric cranes, of electric capstans, of lifts, etc., tends to become developed and constitutes an important improvement. It results in the more frequent use of buildings with several floors. (*Applause.*)

The President. (In French.)— The fourth reporter, Mr. Kain, has unfortunately died

and we can only express our regrets at the death of this eminent man. (*Approval.*)

Mr. Kramer, who was to replace him, is detained at the 1st section and will not be able to be here before 2 o'clock. As however Mr. Kain's report and his conclusions are in our hands, I think there is no disadvantage in continuing the discussion. (*Approval.*)

I therefore propose to you to begin the general discussion at once. This will not prevent us from making any alterations if Mr. Kramer brings forward new ideas and suggestions. We, moreover, start from the principle that the first conclusions which we draw up are not to be considered as final.

You seem to agree that our discussion should take as basis the conclusions given in Messrs. Jullien and Leverve's report. That will of course not prevent us from taking the other opinions also into consideration.

You will find these conclusions in the two last pages of their report; the following is the first clause :

" The preceding information leads us to conclude, as regards large passenger stations, that in order to obtain the maximum working capacity, combined with safety of working, it is advisable in the first place to divert from them everything connected with the local goods and parcels services."

Mr. Weiss, *vice-president.* (In French.) — That conclusion seems to me to be too absolute.

The statement is : " It is advisable in the first place to divert from them everything connected with the local goods and parcels services."

There is no objection in accepting this wording as regards goods, but the same does not apply to parcels; those are often conveyed by special trains, but frequently also by passenger trains. Under these conditions it is not possible to keep the parcels service and the passenger service entirely separate. We ought to say : " and, as far as possible, everything connected with the parcels service ".

Parcels must be handled near the passenger platforms.

Mr. Jullien. (In French.) — We quite agree with Mr. Weiss's proposal.

The President. (In French.) — Then there is no difference between Mr. Jullien's opinion and that of Mr. Weiss.

Mr. Jaggard, *reporter.* — Does this conclusion mean that the baggage service shall be entirely apart and independent from the passenger service, or in the same station, but with entirely distinct arrangements? To give an example, I will cite the new station of the Pennsylvania Railroad, at New York : the baggage is handled upon the same general station level as the passengers, but on the arrival of the trains at the platforms the baggage is handled by special means in such a manner as to cause little or no interference with the movement of passengers; the baggage is conveyed by elevators to the proper floor, and thence is trucked to the baggage room, without interfering with the other station operations. I wish to know whether the conclusion takes account, in its wording, of an arrangement of this kind, which seems to me to be very well worked out.

Mr. Jullien. (In French.) — It is a

question of settling a wording which will satisfy everybody. We did not take the American system into consideration, but it seems that the parcels service and the passenger service are distinct and separate in some cases, but not in others.

Mr. Weiss. (In French.) — Are these installations, for lowering parcels to the subways, at the same place at which passengers get out or at a place specially used for this service?

Mr. Eckenstein, *secretary-reporter.* — The conclusion in the report for America does not mean exactly the same thing as that given in Messrs. Jullien and Leverve's report.

Mr. Jullien. (In French.) — In order to come to a general agreement, one might say :

" As regards large passenger stations, it is advisable, in order to obtain the maximum working capacity, combined with safety of working, to divert from them everything connected with the local goods service. It is also advisable to keep separate, as far as possible, the installations used for the passenger service and those used for the parcels service."

— Adopted.

The President. (In French.) — We pass to the second conclusion :

" It is also advisable to concentrate the suburban service on tracks which are in principle reserved for it; but to utilize at certain hours or on certain days, when one of the two traffics, suburban or main line, becomes of preponderating importance, either the main lines for the suburban service, or the suburban lines for the main-line service."

— Adopted.

" The establisment of large scissors crossings at the entrance of stations, which makes it possible to receive a train coming from any direction on any of the tracks, tends to become general and seems to be an excellent means for increasing the working capacity. The use of power-operated signals and switches, which can be set easily and quickly, and the use of which tends to become general, makes it possible to utilize these connections under the best conditions. It is, finally, an advantage to have, in front of the different platforms, tracks making it possible to change locomotives quickly or to alter the composition of trains quickly. A set of marshalling sidings near the station, and connected with it by independent tracks, is also a very useful addition to the installation."

— Adopted.

" When the local conditions allow it, it is as a rule of advantage to adopt either the type of a station with floors, or the type of mixed station, that is to say including tracks at two different levels. The ground is then utilized better, the passengers can be more easily distributed among the various platforms, and the luggage service can be carried out with much less inconvenience to the passengers."

Mr. Bagwell, Midland Railway, England. — I shall be glad if the reporter will tell as whether he considers the arrangement of floors at different levels to be as advan-

tageous in the case of through stations as in the case of terminal ones.

Mr. Leverve. (In French.) — The stations with different floors have perhaps greater advantages, as regards the movement of the passengers and the handling of the luggage, in the case of through stations than in that of terminus stations. In the latter case, the operations can be carried out on the cross platform at the end of the tracks; but this is not possible in the case of through stations. But it may also be observed that terminus stations are generally inside large towns, where stations with floors may also present considerable advantages.

Mr. Bagwell. — The answer satisfies me.

The President. (In German.) — Would it not be advisable to make a small alteration in the conclusion so as to draw a distinction between through stations and terminus stations?

Mr. Weiss. (In French.) — I propose that we should say :

" When the local conditions allow it, it is often of advantage to adopt, etc."

Mr. Bagwell. — I support that.

— The conclusion as amended is adopted.

The President. (In French.) — " The use of mechanical appliances for handling the luggage is much to be recommended, and, at stations with floors, the use of elevators to save the public the mounting of stairs, appears to be an important improvement, particularly when those elevators are of the continuous-action type."

Mr. Jaggard. — Where movable staircases and like devices are used, what arrangement is there for taking care of invalids or children? In large stations it frequently happens that as many as 50 such passengers a day would have to move between levels. Is it not necessary to install elevators for the handling of these people? If so, is not the double arrangement much more expensive than providing elevators only?

Mr. Jullien. (In French.) — I think that it is useful to place employees by the mechanical appliances for facilitating the conveyance of the passengers. Where there is a difference of level, fixed staircases are always necessary, but the luggage lifts can be used, exceptionally, for invalids. The two arrangements should always exist side by side.

Mr. Jaggard. — That is entirely satisfactory.

The President. (In French.) — In exceptional cases, it is advisable to take exceptional measures. Should the conclusion not be modified to this effect?

Mr. Jullien. (In French.) — We do not propose to abolish the fixed staircase where a moving staircase exists. The public must have the choice between the two.

The President. (In French.) — Taking the observations which have been made into consideration, I now put the conclusion to the vote.

— Adopted.

" It has to be added that it is rather exceptional to have to build a whole new large passenger station. It is much more

usual to have to modify or enlarge an existing station ; one is then hindered by local difficulties from applying the principles we have expounded, except to a limited extent."

I think it useful to remark that lately whole stations have been entirely rebuilt, and that several stations have been replaced by one single one. Now it is only when it is a question of a new station that it will be possible to apply the principles which have just been enunciated.

It is in that sense, I think, that the conclusions are to be understood.

— Adopted.

We now pass to the conclusions relating to large goods yards, the first clause of which is as follows :

" Shunting yards can as a rule be built in the open country and constructed to suit the purpose they are intended for, without having their design influenced by local conditions foreign to the working conditions of lines which are to be provided for."

Mr. Kareischa, *principal secretary*. (In French.) — The wording of this clause seems to me to be too absolute. As local conditions can change, the wording should be slightly modified and run : " Shunting yards can, as a rule, be built in the open country and constructed to suit the purpose they are intended for, without having their design less influenced thant hat of passenger stations by local conditions foreign to the working conditions of lines which are to provided for."

Mr. Ulbricht, *vice-president*. (In German.) — I propose simply to say second sentence : " Their design is less influenced by ..."

Mr. Leverve. (In French.) — We could divide the clause and say : " Shunting yards can as a rule be built in the open country and constructed to suit the purpose they are intended for. Their design is in fact less influenced than passenger stations by local conditions foreign to the working conditions of lines which are to be provided for."

Messrs. Kareischa and Ulbricht. (In French.) — We agree.

— The first clause as amended by Mr. Leverve is adopted.

The President. (In French.) — We now pass to the second clause.

" Such yards, it seeems, should in all cases include three sets of sidings for : the standing after the entry, for the sorting and, finally, for the marshalling and standing before the start, of the trains to be dealt with. The length of those sidings depends on the length of the trains, and their number, on the density of the traffic."

Mr. Kareischa. (In French.) — I propose to add at the end of that clause : " and the shunting operationes ".

Mr. Leverve. (In French.) — Exactly.

Mr. Petschkovsky, Russian State Railway. (In French.) — I find in this clause that the number of the sidings depends on the density of the traffic. But the number of the sidings depends also on the part played by the station in the group of stations of a given railway system, and there can be a busy traffic without that

station having to make up trains to be dispatched to great distances. Each large station plays a certain part in a group of other goods stations. It follows that stations must add other sidings, because the wagons for long-distance trains must often wait a certain time, sometimes more than twenty-four hours, sometimes even forty-eight hours.

Hence it should be stated that the number of sidings depends on the density of the traffic and on the part played by the station in the group of stations of a given railway system.

Mr. Leverve. (In French.) — Mr. Petschkovsky's remark is true. That sentence in our conclusions is too absolute.

Evidently the number of sidings does not depend only on the density of the traffic, as a yard catering for coal pits and having to send off much coal can have much traffic and very few sorting sidings.

It should be stated that the number of the sidings is affected by the different conditions existing on each system.

We consider the set of reception sidings on which the trains are received on arrival and from which the wagons are then sent, either by means of a saddle-back or by means of a continuous incline, to the sorting sidings proper. The number of sidings of this set must be large enough to be able to hold all the trains which may arrive before the wagons are shunted.

As regards the set of sorting sidings proper, the number of sidings necessary depends on the number of lines which run into the yard and on the conditions which obtain. If a yard must make a special classification for fifteen different stations, then there must be fifteen sidings available. If it has to serve ten differen directions, and if there are three destinations on each of these lines, thirty sidings would be required in order to make complete sorting possible.

Then there is what we call the geographical classification which is effected by means of gridirons.

One might perhaps say in the conclusion : " The number of sidings is determined by the number of lines which have to be served and by the importance of those lines."

Mr. Kareischa. (In French.) — And by the importance of the classes of trains.

Mr. Leverve. (In French.) — If a line is important, we give it two, three tracks.

Mr. Descubes, French Eastern Railway. (In French.) — Certain lines can be divided into several sections. Hence one should say : " lines or sections of lines ".

Mr. Jullien. (In French.) — While I agree with the remarks which have just been made, it seems to me impossible to consider all these details. I accordingly propose the following wording : " The length of the siding depends on the length of the trains, and their number, on the density of the traffic and the number of directions which have to be served ".

Mr. Jaggard. — This portion of the conclusions shows distinctly the difference which exists between yard plans in Europe and in America. We find further on this phrase : " We can then double the facilities and made two distinct groups, one for each direction ". This seems to indicate that it is intended to utilize the three consecutive yards in the same direction as

long as the traffic is not too heavy; then when the movement becomes large, to establish separate yards for the handling of the traffic in the different directions. Take the case of a yard lying from west to east, and comprising three groups: The first group is a reception yard; the second is a classification yard, and the third is a departure yard. With a series of yards so arranged, the trains that come from the west are conveniently handled in accordance with the plan. If, on the other hand, a train comes from the east, it is necessary that it should pass by the entire group and be handled from the west end; as a result a useless detour is made.

In America, such an installation would have a length of two or three miles; consequently, the trains which arrived from the wrong direction would make a useless journey of five or six miles. This does not seem to me to be advantageous, and it can scarcely be the purpose of the reporters to recommend the employment of one group of yards only. It would seem preferable to so dispose the initial outlay as to allow a better handling of a small traffic, but to so plan the yards as to permit of an expansion later on into two separate systems, each composed of three yards, one being for each direction.

I read later in the report of Messrs. Jullien and Leverve:

> With the arrangement on a continuous slope, we are obliged to concentrate all the assorting movements in the same direction for cars coming into a station from all directions. The receiving tracks for all directions are grouped at one extremity, A, the departure tracks at the other extremity, B, and all the cars are sent in the direction A to B.

This seems to confirm my impression that unnecessary movement is contemplated.

A little further on, the same reporters say:

> In hump yards one can, when the importance of the traffic justifies it, as at Mannheim, arrange side by side two series of tracks, where are assorted simultaneously in opposite directions the cars which arrive at the two opposite extremities of the yard.

I should like to advocate that it is certainly desirable for us to help the science of railroading by making progress. We ought to be careful about approving in conclusions things that are perhaps done now, but which we know are not the best that can be done. We ought to state that in theory the best plan consists in anticipating an independent arrangement in each direction. As in the case of the stage coach, one uses and is content with this method of travel if he has no better way of travelling, but he hopes to get that soon.

To cite an example, I would mention the classification yards at Altoona: A few years ago the classification of the west-bound empty and loaded movement was accomplished by an arrangement which involved reverse movement, but there resulted such difficulties that a very great expense was incurred to better the arrangement. Then the hump yard system for west-bound classification was established, and now there is a complete group of separate sorting yards for each of the two directions. It will be seen by some figures how important the movement in this yard is: The average number of cars switched daily at Altoona in the busier months is about 10,000. The weight of

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a large proportion of the cars is about 70 tons. The reconstruction of the yard cost about $3,000,000.

I think it would be better to say that the best solution consists in always anticipating two groups of classification yards, suited to the two directions, but in the beginning to avoid a complete arrangement in one direction only, by adopting a plan which will allow, even at the start, facilities for classification in two directions, so arranged, as to be capable of being expanded into two complete systems.

The President. (In French.) — Mr. Jaggard's remarks bear on the following two clauses :

" When the yards have to provide for a very busy traffic, other sidings of less importance are added for the geographical sorting.

" Finally, these can all be doubled, so as to have two distinct complete sets, one for the one direction and the other for the other."

I think that Mr. Jaggard aims chiefly at the last sentence and that he would place at the head of the conclusions the general principles concerning the modification or multiplication of certain arrangements at stations.

Mr. Leverve. (In French.) — The conditions considered by Mr. Jaggard are peculiar to a few large yards where 10,000 wagons have to be dealt with per day. I think that yards of this importance do not exist in Europe, and even in America they must be very rare. Our report applies, it is true, to large yards, but not to exceptional yards of which perhaps only three or four exist in the whole world.

Meeting held on 5 July 1910 (afternoon).

The President. (In French.) — I call upon Mr. Jaggard.

Mr. Jaggard, *reporter.* — I beg leave to state :

" Yards ought to have ordinarily three groups of tracks, for a receiving yard near the entrance, a classification yard, and a departure yard. The length of the tracks depends upon the length of the trains, and their number depends upon the density of traffic and other circumstances that may arise."

When a yard is to accommodate a very extensive traffic, one has to add to these yard groups others of less importance to allow geographical classification; if the traffic is not sufficiently important to render necessary the two arrangements cited above, one for each direction, it is expedient to form provisional plans in order to avoid reverse movements; as far as possible they should be planned in a way to permit later growth, in the manner above indicated.

It is considered that reverse movements are wrong in principle, and that they bring difficulties of operation which should be avoided.

Mr. Leverve, *reporter.* (In French.) — In my opinion, there is something lacking

in the conclusion proposed by Mr. Jaggard. It states at the end that it is advisable to make provision for future duplication for wagons in each direction. Now at the beginning, there is no question of this desideratum and Mr. Jaggard limits himself to repeating the terms of our conclusions.

In order to make the final part of the proposal agree with the initial part, a slight modification should be introduced, and we should speak of the system for each direction.

Mr. Reverdin, *secretary-reporter*. (In French.) — Mr. Leverve will be satisfied if the phrase in question is preceded by the following sentence : " Finally, these can be doubled, so as to have two distinct sets, one for the one direction, another for the other."

The President. (In French.) — That would then only be an addition.

Mr. Reverdin. (In French.) — This is the proposal :

" Such yards, it seems, should in all cases include three sets of sidings for the standing after entry, for the sorting and, finally, for the marshalling and standing before the start, of the trains to be dealt with. The length of these sidings depends on the length of the trains, and their number, on the density of the traffic.

" Where the station has to deal with a very busy traffic, to these sidings other sidings of less importance are added for the geographical sorting. Finally, they can be doubled so as to have two distinct sets, one for the one direction and the other for the other."

Here would come the new wording proposed by Mr. Jaggard :

" When the traffic is not important enough to make the above-described arrangements necessary, it is advisable to make provisional installations making it possible to avoid movements in opposite directions.

" These installations should be designed, as far as possible, with a view to future enlargements. It must be recognized that movement in opposite directions is wrong in principle ; it increases the cost of working and makes it more difficult."

Mr. Serani, Italian State Railway. (In Italian.) — Sorting yards must satisfy the double condition of making it possible to make up trains for the same destination and trains for the different stations on one and the same line.

The very examples given by Messrs. Leverve and Jullien lead to the deduction.

In fact at Mannheim and at Nuremberg yards, which have 153 and 110 kilometres (95·32 and 68·35 miles) of track respectively, as well as at Lumes yard which has only 53 kilometres (32·93 miles) of track, there are not only three sets of sidings for reception, for sorting by direction and for departure, but there are also one or more sets of sidings for making up trains for the successive stations on one and the same line.

Hence at large sorting yards it must be possible, with wagons coming various ways, not only to make up trains for given directions, running to given stations, but it must also be easy to make up trains intended to serve all the stations on one and the same line.

Mr. Jullien, *reporter*. (In French.) — The

difference of opinion between Mr. Jaggard and ourselves is above all due to the fact that we are not considering the same subject. The American reporter considers large stations to be those where 10,000 wagons are dealt with per day. In our opinion it would be excessive to have such a complete installation at the yards which we have considered, yards where only 3,000 to 4,000 wagons are dealt with per day.

In order to come to a general agreement, we propose to modify the fourth clause of our conclusions as follows :

" Finally, one can double them so as to form two distinct complete sets, one for the one direction, the other for the other. "

" It is very desirable to do this in the case of a station of very great importance, where the traffic justifies the expense. It is advisable to design the installations in such a way as to admit of future increase of traffic."

Mr. Maresch, Rumanian State Railway. (In French.) — The expression " one for the one, the other for the other " might give rise to confusion.

It would be better to say " two distinct sets for the two directions ". Moreover, these sets should be connected, for in Germany the wagons coming from the north go to the south and *vice versa*. It is then necessary to have easy ways for passing from the 1st set to the 2nd and *vice versa*.

Mr. Leverve. (In French.) — Mr. Jaggard laid much stress this morning on the importance of sorting in the one direction the wagons arriving at the one end, and of sorting those arriving at the other end in the opposite direction, so that no wagon need make any double journey.

In our conclusions we used the terms " the one direction and the other " without attaching any geographical meaning to them.

There is one first system including three sets of sidings for trains coming from the one side, and a second system for those coming from the other. But it is quite certain that for one given line there will be wagons arriving from the south and wagons arriving from the north. If we call the lines on the north side 1, 2 and 3, and the lines on the south side 4, 5 and 6, we can have wagons coming on line 1 which are intended for line 2 and which consequently must leave on the same side as that on which they arrived. Hence, it is not possible to avoid having wagons making a double journey. There are many cross lines, and wagons coming from the east, for instance, may be divided between the north and south lines.

It is hence impossible to avoid cases of double journeys.

That being so, I think that the wording proposed by Mr. Jullien should be satisfactory to everybody.

Mr. Jullien. (In French.) — This is the new wording which we have the honour to propose.

" Finally, they can be doubled so as to have two distinct complete sets for the two chief directions which have to be provided for, connecting them so as to make it possible to pass from one to the other. It is very desirable to do this in the case of a station of very great importance, where the traffic justifies the expense. It is advisable to design the installations in such a way as to admit of future increase of traffic."

Mr. Kareischa. (In French.) — We should say : " two distinct systems " instead of " two distinct sets ". (*Approval.*)

Mr. Maresch. (In French.) — It is also necessary to add " with convenient connections between the two systems ". This is essential in the case of important yards.

Mr. Jullien. (In French.) — The next paragraph meets this points. It runs : " It is a great advantage to arrange these different sets, as well as the running lines, in such a way as to obtain a continuity of movement in the shunting operations and to eliminate any interruption of these operations owing to the arrival or departure of trains."

Mr. Maresch. (In French.) — In the large yards in Germany, there are two systems which are nearly independent of each other.

Mr. Jullien. (In French.) — In order to pass from one line to the other, the wagons must be sorted.

Mr. Maresch. (In French.) — In order to pass from the northern system to the southern system, the wagons use the connecting lines.

The President. (In French.) — The following is the fourth clause proposed by Mr. Jullien :

" Finally, these can all be doubled so as to have two distinct complete sets, for the two chief directions, connecting them so as to make it possible to pass from one to the other. It is very desirable to do this in the case of a station of very great importance, where the traffic justifies the expense. It is advisable to design the installations in such a way as to admit of future increase of traffic."

— Adopted.

The President. (In French.) — Would it not be advisable to reconsider the second clause ?

It was said this morning that the number of the sidings does not exclusively depend on the number of the trains.

Mr. Jullien. (In French.) — The following wording has been agreed to :

" The number of the sidings depends on the density of the traffic as well as on the number of directions which have to be served."

Mr. Kareischa. (In French.) — I should like to have the idea expressed that the number of sidings depends on the sorting system adopted.

Mr. Jullien. (In French.) — It depends on the nature of the traffic and not on the nature of the goods.

Mr. Leverve. (In French.) — We might say : " The number of the sidings depends on the density and on the subdivision of the traffic, that is to say, on the number of lines ending at the station and on the subdivision of the traffic."

We may assume that at all stations of a certain importance there is a saddle-back or an incline.

Mr. Kareischa. (In French.) — Sorting with a saddle-back nearly always takes twice as long as sorting with an incline.

As for the time of standing still, it depends on the set of sidings.

Mr. Jullien. (In French.) — That is so if we consider the set of reception sidings.

But that is not the case with the set of sorting sidings proper. It is difficult to express this idea in two lines.

Mr. Kareischa. (In French.) — If you say that the number of sidings does not depend on the density of the traffic, the question is not solved.

Mr. Jullien. (In French.) — I propose to say :

" The length of these sidings depends on the length of the trains, and their number on various conditions, more especially on the density and the nature of the traffic, on the method of sorting and on the number of directions which have to be served.

" When the yard has to provide for a very busy traffic, other sidings of less importance are added for the geographical sorting."

Mr. Serani. (In French.) — I propose to word the second clause as follows :

" Such yards, it seems, should in all cases include three sets of sidings for : the standing after the entry, for the sorting and, finally, for the marshalling and standing before the start, of the trains to be dealt with."

— Adopted.

Mr. Leverve. (In French.) — For the next sentence, I propose the following :

" The length of the siding depends on the length of the trains, and their number, on the density of the traffic and the number of directions which have to be served. "

— Adopted.

The President. (In French.) — We pass to the third clause. Mr. Serani proposes the following :

" At very large stations, where a very busy traffic has to be provided for, other sidings of less importance are added for the geographical sorting."

— Adopted.

The President. (In French.) — We pass to the fifth clause :

" It is a great advantage to arrange these different sets, as well as the running lines, in such a way as to obtain a continuity of movement in the shunting operations and to eliminate any interruption of these operations owing to the arrival or departure of trains."

Mr. Maresch. (In French.) — I propose to add to the end of this clause : " or to the movement of engines."

— The clause as amended is adopted.

The President. (In French.) — We pass to the sixth clause :

" Shunting yards cannot practically be built with a continuous incline unless the ground has a natural slope; and in most cases it appears preferable to have saddle-backs. The skid seems to be the best appliance for stopping wagons."

Mr. von Rybicki, Austrian State Railway. (In German.) — I will ask the meeting whether the results of existing experience are such as to make it possible to assert this as definitely as asserted in the conclusions. In my opinion, there are different points in favour both of the one and of the other system. In the first place one has to consider the cost of construction, then the number of shunting engines

required, which is of less importance than with the other systems, and, finally, the climatic conditions and the number of wagons damaged. Certain of those factors are beyond doubt in favour of the continuous incline. I therefore repeat my question : Is there really enough experience to justify that saddle-backs should be recommended in such cases?

Mr. Ulbricht. (In German.) — I absolutely agree with the opinion expressed by Mr. von Rybicki. I also cannot admit that a continuous incline is only to be preferred if the ground has the necessary slope. From the financial point of view, that theory would no doubt be correct in many cases. But there are also many cases where a continuous incline can very well be constructed on level ground. I am just thinking of a case which exists on the Saxon State Railway, and where, as I have just stated, the configuration of the ground was not the preponderating factor. It can also not be definitely said, from the point of view of working, that the saddle-back is absolutely superior. According to the experience gained on the Saxon State Railway, sorting operations on a continuous incline are carried out under such satisfactory conditions that it is hardly possible to assert in a general way that a saddle-back is superior.

Mr. Leverve. (In French.) — The answers we have received seem to show that the continuous-incline method is to be preferred because the sorting is effected more quickly. I must however record that in the case of large stations, the system more frequently adopted is that of a saddle-back. It accordingly seems that railway administrations prefer the saddle-back system to the continuous-incline system.

Mr. Weiss. (In French.) — The first sentence of that clause of the conclusions is too absolute. We should modify it and say : " When the ground has a natural slope, sorting yards with continuous inclines are to be preferred. " In that case, the last words should be struck out : " and in most cases it appears preferable to have saddle-backs ".

Mr. von Rybicki. (In German.) — I think there is a misunderstanding. The choice of system depends on the financial questions. There are so many factors to consider that the configuration of the ground cannot be the sole criterium. I have to build a sorting yard on the railway which I manage, and with this object in view I sent a commission to Nuremberg, to Hesse, and to various other points. I collated the information collected and considered several schemes, but as yet I have not definitely decided whether I will adopt the saddle-back system or the continuous-incline system. Besides the cost of construction, one also has to consider future working expenses. I am hence of opinion that the question of the ground is a secondary one. The choice of system depends on the results given by the calculations, which depend on the number of the wagons, the climatic conditions, etc.; hence I doubt whether I can give any preference to either system in such a definite way.

Mr. Jaggard. — In America the hump has given very good results, and is generally considered the best system. Certain

yards have even been remodelled to introduce this feature.

Mr. Dantscher, Bavarian State Railway. (In German.) — The results obtained by the Bavarian State Railway at Nuremberg sorting yard which is on a continuous incline, are very satisfactory, and I do not think that we can express an absolute preference in favour of the saddle-back system. I am of opinion that in certain cases where the conditions are similar to those at Nuremberg, it is very suitable to construct sorting yards with continuous inclines, above all because the working expenses are materially lower. It is nevertheless possible, in the case of yards of exceptional size, that the saddle-back system may be superior taking the whole operation into consideration.

At Nuremberg very special conditions had to be allowed for. All the trains, both those coming from the north and the south and those coming from the east and the west, collect together at a reception station at the east end of the shunting yard, in order to be dealt with subsequently. Owing to the division into two groups, the traffic of the whole yard is sorted, on the one hand, for the directions north and west, on the other, for the directions south and east.

When the conditions are such that the different traffics balance each other, a continuous-incline installation can always be advantageous, above all when it is a question of a traffic of about 5,000 wagons per day. In the case of a very busy traffic, of say 8,000 to 10,000 wagons per day, the use of saddle-backs may be preferable, particularly if the different traffics balance each other less well than at Nuremberg.

I think that the two systems must be applied in accordance with the local conditions, and that neither the one nor the other is to be preferred absolutely.

Mr. Leverve. (In French.) — Taking into consideration the remarks which have been made, I propose to say :

" Shunting yards can be built either on a continuous incline, or with saddle-backs. The choice between the two systems has to be decided in each individual case, taking into consideration the nature of the traffic, the cost of construction, which varies with the local conditions, and the eventual operating expenses of each of the two systems."

The President. (In German.) — We will reconsider the question of this wording. In the first place I should like Mr. Watson to address the meeting.

Mr. H. A. Watson, North Eastern Railway, Great Britain. — During the last few years we have built three large sorting yards with saddle-backs, and we are so well satisfied with the results obtained that future sorting yards will be constructed on the same principles, the advantages being :

1° This system makes it possible to operate a greater number of wagons than formerly;

2° Goods are damaged much less ;

3° The whole of the sorting operations can be carried out very quickly.

In fact I fully agree with the opinion of the American delegates that an absolute preference should be given to saddle-backs.

The President. (In German.) — Would it not be advisable to add to the conclu-

sions that the English and Americans give the preference to saddle-backs?

We find ourselves face to face with two opinions which have the right of being expressed in the conclusion. In the wording submitted by the French reporters, it is said that the saddle-back is more often to be preferred. The second wording simply says that the two systems, saddle-back and continuous incline, are of equal value and that any choice between them depends absolutely on the conditions of each individual case.

I think that we must express an opinion as to these two solutions and say whether we will give absolute preference to the saddle-back or whether we let the choice depend on the local conditions. It will hardly be necessary to discuss the details of the wording, but simply to say which of the two systems is to be preferred ; the second wording has only been proposed as a result of the various objections raised.

As the reporters inform us, there are also in England and in America many yards with continuous inclines. Hence, it is necessary that I should reopen the discussion of these questions of principle.

Mr. Ulbricht. (In German.) — It is not possible to take into account the opinion of a certain number of delegates by adding to the wording proposed by the reporters (and I think well of this text), a sentence stating that exceptionally satisfactory results have been obtained with saddle-backs on rather a large number of railways? (*Hear, hear !*)

Mr. Petschkovsky. (In French.) — Is from the purely technical point of view a sorting yard with a continuous incliue always preferable?

Mr. Descubes. (In French.) — I think that the saddle-back is often preferable from the technical point of view. If at certain stations it is a question, for instance, of dividing a train of 60 wagons into a number of smaller sections, of 10 and 15 wagons each, the continous-incline system may have advantages. But matters are different if the train is to be divided into 30 sections of from 1 to 3 wagons each. It is in fact important that these sections should clear as quickly as possible the switches which have to be operated. Consequently the steeper the gradient at the start and at the switches, the more quickly the latter will be cleared and the greater the output of work.

In this case, which is much more usual than the other, the saddle-back with a steep gradient is to be preferred.

Mr. Leverve. (In French.) — The words used in our concluaions are a little absolute and perhaps we go rather far in saying that " shunting yards cannot practically be built with a continuous incline unless the ground has a natural slope ".

There are cases where this condition does not exist and where the continuous-incline system may still be superior. Such is, for instance, the case mentioned by Mr. Descubes when important numbers of wagons moving together have to be operated.

It would hence be better to retain the wording which I just proposed.

Mr. Eckenstein, *secretary-reporter.* — The American delegates agree to this wording.

The President. (In French.) — As everybody agrees, I declare it adopted.

We now pass to the next sentence :

" The skid seems to be the best appliance for stopping wagons."

Mr. Jaggard. — The skid is not used in America or England. Experience has demonstrated that in America heavy cars are jolted out of position on the tracks when the skid is used. It is possible that it is different in Europe ; but as our conclusions interest the entire world, I propose that we modify the conclusion and say that hand-brakes under good conditions of inspection seem the best way to stop the cars in America and in England. The skid is preferred by the Continental railways.

Mr. H. A. Watson. — I agree with Mr. Jaggard. On our railway, we have made trials which have shown that heavy wagons weighing 30 tons are not safely stopped except by means of the hand brake. On the other hand, light wagons are easily stopped by means of a skid. The selection of the one or the other system will accordingly depend on the type of wagon.

Mr. Leverve. (In French.) — Mr. Jaggard's wording appears to me to be satisfactory. It shows that the system adopted in America and in England differs from that adopted on the Continent. He knows better how things stand in this respect than we do.

I also think that the choice between the two systems is affected by the nature of the rolling stock. It is possible that in America, where large wagons are used, the skid tends to derail these vehicles. On the other hand, the necessity of having an employee on each wagon in order to apply the brake is less objectionable in the case of large wagons than in that of small.

Mr. Ulbricht. (In German.) — Would it not be advisable to say : " The best appliance for stopping light wagons and wagons of medium weight appears to be the skid." In the case of very heavy wagons, we ourselves have found that the sudden stopping produced by the skid can easily produce damage. If we adopt this limitation, we at the same time meet the wishes of the Americans, and they will no doubt be able to agree to this.

Mr. Eckenstein, *secretary-reporter.* — The American and English delegates agree to this wording.

The President. (In French.) — The conclusion will accordingly run as follows :

" The skid seems to be best appliance for stopping light wagons."

— Adopted.

The President. (In French.) — We still have to consider the last clause :

" The mechanical handling of the goods or wagons in the buildings and near the buildings, by means of hand cranes or electric cranes, or electric capstans, of lifts, etc., tends to become developed and constitutes an important improvement. It results in the more frequent use of buildings with several floors."

— Adopted.

I now call upon Mr. Kramer to give a summary of the third report, that of Mr. Kain, relating to the same question.

Mr. Kramer, Hungarian State Railway. (In French.) — I beg to thank the President for the kind words he has spoken in memory of my late colleague Mr. Kain, words which the meeting has fully endorsed. I also thank him for kindly asking me to give a summary of his report.

That being said, I think I may limit myself to adding that the conclusions provisionally adopted by the section are in agreement with those given in Mr. Kain's report. I hence entirely agree and propose that they should be definitely adopted.

The President. (In German.) — Does the section agree with Mr. Kramer that the provisional conclusions should be adopted?

Many delegates. — Yes, yes!

— The conclusions provisionally adopted were then put to the meeting and adopted definitely.

DISCUSSION AT THE GENERAL MEETING

Meeting held on 14 July 1910 (afternoon).

MR. P. WEISSENBACH, PRESIDENT, IN THE CHAIR.

GENERAL SECRETARY : MR. L. WEISSENBRUCH.

FIRST ASSISTANT GENERAL SECRETARY : MR. MÜRSET.

SECOND ASSISTANT GENERAL SECRETARY : DR. A. BONZON.

Mr. Kareischa, *principal secretary of the 3rd section*, read the

Report of the 3rd section.

(See *Journal de la huitième session*, No. 8, p. 3.)

" Mr. JAGGARD gave a summary of his report which was divided into three parts: *a*) arrangements at the stations, measures taken for improving the service and increasing the safety, stations with separate floors in order to utilize the space in large towns better; *b*) arrangements for obtaining continuity of movement in shunting operations; *c*) baggage service, subways.

" Mr. JULLIEN gave a summary of his report as far as passenger stations were concerned. In order to utilize existing tracks as much as possible, it was advisable to keep the suburban passenger service and the main-line service separate. Subways added to the safety of the passengers. At stations with separate floors, lifts and continuous-action systems of conveyance were being used. The parcels service could also be facilitated in similar ways.

" Mr. LEVERVE spoke about goods yards. Sorting operations were carried out by means of three sets of sidings. The length of these sidings depended on the number of wagons dealt with. The movement of the wagons was started by means of locomotives or by gravity. Such sorting sidings could be either on a continuous incline, or with saddle-backs. The wagons were stopped by means of skids. The reporter concluded with some information about the mechanical handling of goods."

LITTERA *A*.

" As regarded keeping the passenger and the parcels services separate, Mr. WEISS (*French Eastern Railway*) remarked that parcels had to be dealt with near the passenger platforms.

" Mr. JAGGARD stated that in America the

parcels were unloaded on the side of the passenger platform, but were taken away through subways.

" Mr. Bagwell (*Midland Railway*) asked, in connection with stations with separate floors, whether these were considered advantageous both in the case of terminus stations and in that of through stations.

" Mr. Leverve remarked that local conditions were the chief factors in the case of terminus stations with several floors, while in the case of through stations this system was best from the point of view of safety.

" Mr. Jaggard remarked that the use of some of the mechanical means of conveyance for passengers gave rise to some difficulty in the case of inexperienced people and of invalids.

" Mr. Jullien answered that the fixed staircases were always necessary and that the luggage lifts could be used for invalids in exceptional cases."

Littera *B*.

" Mr. Kareischa (*Russian government*) proposed to begin the conclusions referring to the goods yards by the following paragraph : " Shunting yards can as a rule be built in the open country and constructed to suit the purpose they are intended for. Their design is, in fact, less influenced than that of passenger stations by local conditions foreign to the working conditions of the lines to be provided for."

" As regarded the conditions determining the number of tracks, Messrs. Kareischa, Petschkovsky (*Russian State Railway*) and Jullien were of opinion that it was also necessary to consider the number of directions to be provided for.

" Mr. Jaggard was of opinion that at large yards, as at Altoona, it was indispensable to have two groups of three sets each, so as to provide for the two opposite directions. This also made subsequent extension easier.

" Mr. Leverve remarked that this conclusion in his opinion only applied to stations of ordinary importance, but not to exceptional and rare cases.

" Mr. Serani (*Italian State Railway*) thought that it was in all cases necessary to have one set of sidings for the geographical sorting.

" Mr. Maresch (*Rumanian State Railway*) suggested an alteration in the wording so as to make the meaning more clear.

" Messrs. Jullien and Maresch thereupon proposed a new wording in the conclusions. As regarded the sidings, it was decided to add " or to the movement of engines " after the words " arrival or departure of trains ".

" A discussion then took place on the relative advantages of saddle-backs or humps, and of continuous inclines, which showed that the former were preferred in America and in England, while on the Continent local conditions formed the chief factor in deciding the question.

" Messrs. Jaggard and H. A. Watson (*North Eastern Railway, England*) preferred saddle-backs. Mr. Dantscher (*Bavarian State Railway*) was more in favour of the continuous incline, but local conditions had to be taken into account.

" Mr. von Rybicki (*Austrian State Railway*) thought that it was not possible to give the preference, in an absolute manner, to either system.

" Mr. Ulbricht (*Saxon State Railway*) said that the practical possibility of having a continuous incline did not merely depend on the natural slope of the ground; such an incline could also be made by utilizing the spoil from earth-works.

" Mr. Descubes (*French Eastern Railway*) described the advantages of saddle-backs when a set of wagons had to be divided into a large number of separate parts; the greater speed of the wagons at starting made it possible to clear the sidings more quickly and to get through more work.

" Mr. Leverve proposed the following wording, which was accepted : " Shunting yards can be built either on a continuous incline, or with saddle-backs. The choice between the two systems has to be decided in each individual case, taking into consideration the nature of the traffic, the cost of construction, which varies with the local conditions, and the eventual operating expenses of each of the two systems."

" The use of the skid was objected to by Messrs. Jaggard and H. A. Watson, who stated that in America and England this had produced derailments in the case of heavier wagons (30 tons and upwards).

" Mr. Ulbricht stated that on the German railways skids had also proved unsatisfactory for heavy wagons. He accordingly proposed a modification in the wording of the proposed conclusions.

" The report of Mr. Kain, who had died, was submitted to the section by Mr. Kramer (*Hungarian State Railway*). He in the first place thanked the meeting for the regrets expressed on the death of Mr. Kain.

" As the conclusions of his report were in general harmony with those that had been adopted, Mr. Kramer agreed with them *in toto*.

" Mr. Serani suggested another slight modification in the wording of the conclusions, which was accepted.

" The section then agreed to submit to the general meeting the conclusions worded as follows."

The President. (In French.) — The following are the

CONCLUSIONS.

Littera *A*.

" As regards large passenger stations, " it is advisable, in order to obtain the " maximum working capacity, combined " with safety of working, to divert from " them everything connected with the " local goods service.

" It is also advisable to keep separate, " as far as possible, the installations used " for the passenger service and those used " for the parcels service. It is also ad- " visable to concentrate the suburban ser- " vice on tracks which are in principle " reserved for it; but to utilize at certain " hours or on certain days, when one of " the two traffics, suburban or main line, " becomes of preponderating importance, " either the main lines for the suburban " service, or the suburban lines for the " main-line service. The establishment " of large scissors crossings at the en- " trance of stations, which makes it pos-

" sible to receive a train coming from any " direction on any of the tracks, tends to " become general and seems to be an " excellent means for increasing the " working capacity. The use of power- " operated signals and switches, which " can be set easily and quickly, and the " use of which tends to become general, " makes it possible to utilize these con- " nections under the best conditions. It " is finally an advantage to have, in front " of the different platforms, tracks mak- " ing it possible to change locomotives " quickly or to alter the composition of " trains quickly. A set of marshalling " sidings near the station, and connected " with it by independent tracks, is also a " very useful addition to the installation.

" When the local conditions allow it, it " is often of advantage to adopt, either the " type of a station with floors, or the type " of mixed station, that is to say includ- " ing tracks at two different levels. The " ground is then utilized better, the pas- " sengers can be more easily distributed " among the various platforms, and the " luggage service can be carried out with " much less inconvenience to the passen- " gers.

" The use of mechanical appliances for " handling the luggage is much to be re- " commended, and, at stations with floors, " the use of elevators to save the public " the mounting of stairs, appears to be an " important improvement, particularly " when those elevators are of the con- " tinuous-action type.

" It has to be added that it is rather ex- " ceptional to have to build a whole new " large passenger station. It is much " more usual to have to modify or enlarge " an existing station; one is then hin- " dered by local difficulties from applying " the principles we have expounded, ex- " cept to a limited extent."

LITTERA *B*.

" Shunting yards can as a rule be built " in the open country and constructed to " suit the purpose they are intended for. " Their design is in fact less influenced " than passenger stations by local con- " ditions foreign to the working condi- " tions of lines which are to be provided " for.

" Such yards, it seems, should in all " cases include three sets of sidings for : " the standing after the entry, for the " sorting and finally for the marshalling " and standing before the start, of the " trains to be dealt with. The length of " the siding depends on the length of the " trains, and their number, on the den- " sity of the traffic and the number of " directions which have to be served.

" At very large stations, where a very " busy traffic has to be provided for, " other sidings of less importance are " added for the geographical sorting.

" Finally, these can all be doubled so as " to have two distinct complete sets, for " the two chief directions, connecting " them so as to make it possible to pass " from one to the other. It is very desir- " able to do this in the case of a station " of very great importance, where the " traffic justifies the expense. It is advis- " able to design the installations in such " a way as to admit of future increase of " traffic.

" It is a great advantage to arrange these " different sets, as well as the running " lines, in such a way as to obtain a con-

" tinuity of movement in the shunting " operations and to eliminate any inter- " ruption of these operations owing to " the arrival or departure of trains, or to " the movement of engines.

" Shunting yards can be built either on " a continuous incline, or with saddle- " backs. The choice between the two " systems has to be decided in each indi- " vidual case, taking into consideration " the nature of the traffic, the cost of con- " struction, which varies with the local " conditions, and the eventual operating " expenses of each of the two systems.

" The skid seems to be best appliance " for stopping light wagons.

" The mechanical handling of the goods " or wagons in the buildings and near " the buildings, by means of hand cranes " or electric cranes, or electric capstans, " of lifts, etc., tends to become deve- " loped and constitutes an important " improvement. It results in the more " frequent use of buildings with several " floors."

— These conclusions were adopted by the general meeting.

SECTION III : WORKING

[656 .257 & 656 .21 (01]

QUESTION X

OPERATION OF SWITCHES AND SIGNALS

A. *Improved centralized installations for operating switches and signals. The use of water, of compressed air, of electricity, for working the transmissions. Electric interlocking. Route levers.*

B. *Arrangements adopted to prevent switches taken from the facing or the trailing side from changing their position before the whole train has passed.*

C. *Use of diagrams to facilitate the consideration of the full utilization of tracks along passenger platforms and the modifications to be made, in cases of urgency, in the way these tracks are used.*

Reporters :

Holland. — Mr. L. H. N. Dufour, engineer to the Company for working the Netherlands State Railways.

Austria, Hungary, Bulgaria, Denmark, Germany, Luxemburg, Norway, Rumania, Russia, Servia, Sweden, Switzerland and Turkey. — Professor Dr. Ulbricht, member of the Board of works, councillor of the Royal Saxony Treasury.

America. — Mr. E. C. Carter, chief engineer, Chicago & North Western Railway.

Other Countries. — Mr. L. Weissenbruch, engineer in chief, director of the safety appliances department of the Belgian State Railways, and Mr. J. Verdeyen, engineer, assistant to the director of the safety appliances department of the Belgian State Railways.

QUESTION X

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Report No. 3 (America), by Mr. E. C. Carter. (See English edition of the *Bulletin* of March, 1910, p. 1337.) . . . . . X — 67

Report No. 2 (Holland), by Mr. L. H. N. Dufour. (See English edition of the *Bulletin* of April, 1910, p. 1361.) . . . . . X — 79

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N. B. — Vide also the separate issues (in red cover) Nos. 21, 37, 41 and 67.

[656 .257 & 656 .21 (01]

REPORT N° 1

(Austria-Hungary, Bulgaria, Denmark, Germany, Luxemburg, Norway, Rumania, Russia, Servia, Sweden, Switzerland and Turkey)

By Prof. Dr. ULBRICHT,

MEMBER OF THE BOARD OF WORKS,

COUNCILLOR OF THE ROYAL SAXON TREASURY.

In order to obtain a good general view of the progress which is being made or attempted in connection with the safety appliances considered under Subject X, it was also necessary to incorporate in this report the chief particulars of the older devices principally used, which have proved reliable. The list of questions sent out therefore also included operation by hand, and to this the first twenty-eight questions are devoted. Power operation is then dealt with in the next nineteen questions, Nos. 29 to 47. Questions Nos. 48 to 65 deal with those devices which can be applied in cases both of hand operation and of power operation in order to obtain special safety measures, with the exception, however, of the electric interlocking of route levers, to which a special section, including questions Nos. 66 to 77, is devoted. Questions Nos. 78 to 94 deal with the measures taken to prevent the moving of switches, whether taken from the facing or from the trailing side, before the whole of the train has passed over them. The last nine questions, Nos. 95 to 103, are devoted to the graphic representation of the occupation of platform tracks at stations where there is much traffic, and to their utilization if any changes are made in the regular time-table.

*

Answers to the list of questions sent out were received from the following administrations :

I. — Members of the German « Verein ».

GERMANY.

Imperial Administration of the Alsace-Lorraine Railway, Strasburg.
Royal Prussian Central Railway Office (of the Prussian-Hessian State Railway), Berlin.
Royal Bavarian State Traffic Ministry; section Munich.
Royal Administration of the Saxon State Railway, Dresden.
Royal Administration of the Wurtemberg State Railway, Stuttgart.
Grand ducal Administration of the Baden State Raiway, Karlsruhe.
Administration of the Oldenburg State Railway, Oldenburg.

LUXEMBURG.

The Administration of the Prinz-Heinrich Railway, Luxemburg.

AUSTRIA AND HUNGARY.

Imperial and Royal Railway Ministry, Vienna.
Administration of the Royal Hungarion State Railway, Budapest.
General Management of the Austrian Southern Railway, Vienna.
Administration of the Austrian North-Western and North-South Railway, Vienna.
Administration of the Aussig-Teplitz Railway, Teplitz.
Administration of the Kaschau-Oderberg Railway, Budapest.

RUMANIA.

Administration of the Rumanian State Railway, Bucharest.

Addendum :

General Management of the Warsaw-Vienna Railway, see under Russia.

II. — Outside the German « Verein ».

DENMARK.

Administration of the Danish State Railway, Copenhagen.

RUSSIA.

Administration of the State Railway, St. Petersburg.
General Management of the Russian North-Western Railway, St. Petersburg.

District Management of the Moscow-Brest State Railway, Moscow.
District Management of the Ssysran-Wjasma State Railway, Kaluga.
District Management of the Weichsel lines, Warsaw.
General Management of the Warsaw-Vienna State Railway (belonging to the German *Verein*).
District Management of the South-Eastern Railway, Woronesh.
District Management of the Moscow-Windau Railway (Moscow-Windau-Rybinsk Railway Company), Moscow.

SWEDEN.

Royal Administration of the Swedish State Railway, Stockholm.

SWITZERLAND.

Administration of the Swiss Federal Railway, Berne.
General Management of the St. Gothard Railway, Lucerne.

In this list, which serves as basis for the further discussion, the Warsaw-Vienna line, although belonging to the German *Verein*, has been included, for the sake of convenience, in the second section, under the heading Russia.

As regards Luxemburg, in which the Prinz-Heinrich Railway is situated, no separate section has been formed; but the information supplied, which only refers to the first part of the questions, has been considered in its proper place. As regards the conditions on the Wilhelm-Luxemburg Railway, the information supplied in connection with the Imperial Alsace-Lorraine Railway applies equally, for that administration manages the Wilhelm-Luxemburg Railway.

As regards the practice on the Russian railways, the information given by the Administration of the State Railway (this controls 22 State lines and more than 10 company's lines) was our principal source of information, but the answers supplied by the managements of the Moscow-Brest, Ssysran-Wjasma, Weichsel and Warsaw-Vienna lines gave valuable supplementary information.

The answers sent by the Russian North-Western, and by the Russian South-Eastern, could not be dealt with in this report, as they were in the Russian language, which the Reporter is not acquainted with. Attempts to obtain them in German, or in French, were unsuccessful.

The Bulgarian State Railway refrained from answering the questions set, for as there is not yet much traffic on the lines of this administration, perfected centralized switching arrangements are not used; and as regards electric operation there is as yet only a small experimental apparatus at Slivnitza.

The managements of the Bukovinia Local Railway, of the Mohacs-Pecs Railway, of the Polessia State Railway, and of the Salonica-Constantinople and Smyrna-Cassaba lines gave similar reasons for their inability to supply the information

desired. The Polessia State Railway, however, drew attention to a special safety system introduced on their lines, known as the Phono-Indicator system.

In order to give a general view of the information collected, we give in the following table the chief items contained in the answers to the 103 questions, arranged under the different countries Germany, Austria-Hungary, Rumania, Denmark, Russia, Sweden and Switzerland. The verbatim reproduction of the answers is, for the sake of comprehensiveness, not attempted. But it was considered important to show what conditions are the prevailing ones in the country in question. In connection herewith it is to be noted that some of the answers were very brief, and that consequently it is not always possible, from the information supplied, to determine the state of affairs as accurately as might be desirable. In the text which follows the tables, attempts are made to give some supplementary information, and to make it easier to obtain a general view of the subject.

Tabular summary of the answers.

QUESTIONS.	Summary of the answers.	
	Germany.	Austria and Hungary.
A. — I. Improved appliances for operating switches and signals. Use of water, compressed air and electricity as sources of power.		
1-28 : *Hand operation.* (The work of moving the signal or switch is done by the signalman.)		
1. When you are newly constructing switching gear, do you use rodding or double-wire transmissions, or both? In which cases do you use the one, in which the other, system of transmission?	Double-wire transmissions are used very extensively for the operation of switches, rodding only exceptionally in the case of short transmissions and minor signal cabins. In Baden and Alsace-Lorraine alone is rodding to be used exclusively in the future for new installations, as double-wire transmissions are considered not to be reliable enough, in case of fracture of a wire.	In the case of new constructions, ble-wire transmissions exclusivel
2. What length of travel of the rodding, or of the wire, do you as a rule use in such transmissions?	In the case of older installations without point lock up to the lower limit of 140 millimetres (5 1/2 inches), rodding; in the newer installations usually 220-240 millimetres (8 11/16 to 9 7/16 inches), rodding; and 500 millimetres (1 ft. 7 11/16 in.), wire. In Bavaria 600 millimetres (1 ft. 11 5/8 in.), and in some cases even 750 millimetres (2 ft. 5 1/2 in.), of travel of wire are used.	As a rule : 500 millimetres (1 ft. 7 11/16 travel of wire, exceptionally 600 millimetres (1 ft. 11 5/8 in.). Austrian Southern goes beyond t up to 680 millimetres (2 ft. 2 3/4 in. the distance between the switch the signal cabin exceeds 250 me (273 yards).
3. Are the switches operated by rodding equipped with separate locking gear, operated from the cabin, and in what cases?	Yes. In Prussia and Alsace-Lorraine as a principle, if passenger trains take the switches from the facing side. A similar system is also adopted in other cases, but only if the switches are at a considerable distance from the signal cabins, if indeed rodding is still used at such longer distances. (In Baden it is used at distances of over 300 metres (328 yards.)	Such locking gear as a rule does enter into consideration, as dou wire transmission is usual. Aussig-Teplitz Railway has such its more important switches wh are taken from the facing side.
4. Have you also used ball and roller bearings for any rotating parts of your switching gear, and with what success?	As a rule not. But trials have been made with ball bearings for semaphore arms and deviation blocks, and have given general satisfaction. In the case of signals not frequently used, it was observed in Alsace-Lorraine that the arms were less liable to become rusted in.	As a rule not. Trials have been m by the Aussig-Teplitz Railway w ball bearings at the supporting rol and deviation blocks, and have sho that friction is materially reduced
5. Are the switches operated by rodding equipped with any electric control, which if the switch is wrong (fracture of a rod, points not home) prevents the setting of the signal or at least enables the cabin to recognize the fault?	As a rule, no. But in Alsace-Lorraine in the case of installations with signals electrically and switches mechanically operated (rod transmissions) the point lock is controlled electrically. If the points are not home however, the signal coupling circuit in interrupted.	No.
6. Do you use, besides the usual cuttable point locks, which react on the cabin, any other devices intended to fulfil some similar function?	No.	Instead of cuttable point locks, react on the cabin, the switch bolt w shearable pin is used nearly exclu vely; this, although cuttable, does react on the cabin. Throwing o the lever after cutting is prevented locking the switch bolt. The Aus Teplitz Railway however also ext sively uses cuttable reacting po locks.

Summary of the answers.

Rumania.	Denmark.	Russia.	Sweden.	Switzerland.
A. — I. Improved appliances for operating switches and signals. Use of water, compressed air and electricity as sources of power.				
1-28 : *Hand operation.* (The work of moving the signal or switch is done by the signalman.)				
case of new construc- s, rodding almost ex- sively, and that on ount of the local wea- r conditions, as well on that of the relia- ty and cheapness of intenance of the rod- g installations.	In the case of new constructions, chiefly double-wire transmissions.	In the case of new constructions, double-wire transmissions are put in nearly exclusively. Only the Weichsel Railway uses rodding to some extent, and the Ssysran-Wjasma Railway uses it exclusively.	In the case of new constructions, double-wire transmission exclusively.	In the case of new constructions, just as in the existing ones, rodding is used almost exclusively. Only in exceptional cases, if the switches are a very long way off, or if it would be difficult to arrange rodding, or if it is a question of switches not taken from the trailing side, are double-wire transmissions, with special point lock, also used.
el of rodding, 236 milli- res (9 5/16 inches). el of wire, 500 milli- res (1 ft. 7 11/16 in.).	As a rule : travel of rodding, 230-250 millimetres (9 1/16 to 9 13/16 inches); travel of wire, 450-500 millimetres (1 ft. 5 11/16 in. to 1 ft. 7 11/16 in.).	Travel of rodding : 209·5 millimetres (8 1/4 inches), Ssysran-Wjasma Railway ; 260 millimetres (10 1/4 inches), Weichsel Railway. Travel of wire, 480-500 millimetres (1 ft. 6 15/16 in. to 1 ft. 7 11/16 in.).	As a rule : travel of wire, 500-520 millimetres (1 ft. 7 11/16 in. to 1 ft. 8 1/2 in.).	As a rule : travel of rodding, 236 and 240 millimetres (9 5/16 and 9 7/16 inches); travel of wire, 475 and 500 millimetres (1 ft. 6 11/16 in. and 1 ft. 7 11/16 in.). In new constructions : wire, 600 millimetres (1 ft. 11 6/8 in.).
but only exception- ly, if they are taken n the facing side and on a curve.	Yes, when the distance between the switch and the cabin exceeds 250 metres (273 yards).	No	Such locking gear does not enter into consideration, as double-wire transmission is usual.	Yes. On the Federal Railway, switches in the main lines, which are taken from the facing side, are specially locked by the wire transmission operating the signal, if they are more than 150 metres (164 yards) from the cabin. Switches with a rod travel of over 400 metres (437 yards) in addition have a special lock, which is operated from the cabin by a double-wire transmission.
	Yes, ball bearings have been used with satisfactory results for signal arms.	No.	No.	No.
only in the case of se operated by wire nsmission. In these es, an alarm rings if points are not home.	No.	As a rule, no.	This control does not come into consideration as double-wire transmissions are generally used.	No.
	No.	Yes, on the State Railway, Siemens & Halske switch-bolts without special point locks.	No.	No, some older installations excepted.

QUESTIONS.	Summary of the answers. (Continued.)	
	Germany.	Austria and Hungary.
7. Have you made any arrangements for preventing the untimely opening (when a route has been made) of the cuttable connexion between the switch lever and the transmission, or do you intend to make such arrangements?	Only in so far as the opening of the connection between the switch lever and the transmission cannot be effected without the breaking of a lead seal, and the special lever required for such opening is kept lead-sealed.	As a rule there is no reason for this switch bolts are used.
8. What construction of cuttable point locks do you prefer in the case of new installations, the locking by clamping the blade and the stock rail together, or by exerting a thrust against the blade from a special point of support, or by some other method?	The locking by clamping the blade and the stock rail is as a rule preferred more recently. Wurtemberg and Baden use the thrust method only.	In the case of the ordinary switch lo the blade is pressed against the st rail by a thrust exerted from a spe point of support. The locking clamping the blade and the stock together is only used at the loca operated switches of the Austr Southern Railway.
9. Have the usual arrangements, by means of which, if a wire breaks, the switch is held in its end position, and the setting of the signal is prevented, proved sufficiently satisfactory to justify the loss of simplicity in construction which consequently results?	Yes. But in some cases these locking arrangements are only considered necessary in the case of switches with long wire transmissions.	Such arrangements are as a rule no be found, as point locks are gener used here. Breakages of the tra mitters have only occurred v rarely. The Aussig-Teplitz Railw speaks in favour of such lock arrangements.
10. Do you under certain conditions have, in the case of switches operated by wire transmissions, even if supplied with point locks and with the arrangement described under 9, special locking gear (control bolts) operated from the cabin, and in what cases?	Yes, in the case of switches taken from the facing side by passenger trains running at higher speeds; also in the case of switches operated from greater distances (over 300 or 350 metres [328 or 383 yards]). In Alsace-Lorraine such special gear is provided in the case of all switches taken from the facing side by passenger trains.	Yes, nearly always in the case of sw ches taken from the facing side passenger trains, operated fron distance; occasionally also in the c of switches on branch lines, but o if the distance between the swi and the cabin exceeds 200 met (219 yards). On the Hungarian lin in the case of switches taken from facing side by express trains.
11. Do you think it advisable to check by means of such controlling locking gear the condition of the switch as a whole, or each blade separately?	The predominant opinion is that it is advisable to check the position of each separate blade. Checking the position of the switch as a whole has however also proved to be reliable. The latter system is preferred by Bavaria in the case of switches having locks of a very simple and reliable construction.	The checking of the position of switch as a whole is as a rule effec by the control bolts used. On Aussig-Teplitz Railway, when two points are moved in successi the position of each is checked.
12. To what extent do you use centralized locking only, instead of centralized operation of switches?	In most cases where simple conditions of traffic do not make frequent operation of the switches necessary; also in cases of greater distances, when it is difficult to see the switches; also when for special reasons an employee is required anyhow (for instance, for attending to gates). Bavaria uses locking as a preliminary safety measure and then limits it to switches taken by ordinary trains from the facing side, and to switches taken by through trains from the trailing side.	At branches in the open line, in orde prevent the premature throwing-o of switches while a train is passi Also at stations when the work conditions are simple and there is little traffic; also when the switc are at greater distances from cabin.

Summary of the answers. (Continued.)

Rumania.	Denmark.	Russia.	Sweden.	Switzerland.
	No.	As a rule, no.	No.	No.
ing by exerting a thrust m a special point of pport is preferred.	The Siemens & Halske or the Schnabel & Henning. (Thrust from a special point of support.)	Locking by exerting a thrust from a special point of support is as a rule preferred. The Warsaw-Vienna Railway pronounces in favour of locking by clamping.	Locking by exerting a thrust against the blade from a special point of support, because in consequence of the system of construction of the standard switches no other methods of locking can be used.	Locking by exerting a thrust against the blade from a special point of support.
	As yet there is not enough experience to make a definite answer possible.	Yes, quite satisfactory when trials of the breaking of wires were made; the breaking of a transmission has only occured very rarely.	As yet there is not enough general experience. On the Stockholm-Rimbo line these arrangements have proved satisfactory.	Yes. The St. Gothard Railway however is unable to decide the question as no case of fracture of a wire has yet occurred.
o the present such con- l bolts have not been ed.	Yes, at the switches which are regularly taken from the facing side, if the length of the wire transmission exceeds about 200 or 250 metres (219 or 273 yards).	Yes, in certain cases of switches in the main lines taken from the facing side; also in the case of entrance switches taken from the facing side, which are at a rather considerable distance from the cabin.	Yes, as a rule in the case of important switches taken from the facing side, particularly at stations at which fast trains do not stop.	Yes, as a rule in the case of switches in the main line taken from the facing side, if the trains run through the station without stopping. The St. Gothard Railway uses control bolts operated by the wire transmission of the signal at all the switches taken from the facing side, which are operated by wire transmissions.
desirable that the posi- n of each blade should checked separately.	It is considered advisable to have control bolts for each of the two blades.	It is preferable to check the position of each blade separately.	It is recommended that the position of each blade should be tested separately, although at present the practice is to check the position of the switch as a whole.	As a rule, the position of the switch as a whole; only in exceptional cases (when the switches are more than 400 metres (437 yards) from the cabin) is the position of each blade checked separately by means of Sigle indicators. The St. Gothard Railway pronounces in favour of checking the position of each blade.
ralized locking is as not used.	At the end of 1907 there were about 700 switches with centralized operation and about 1,700 with centralized locking.	Centralized locking is as a rule not used. As a substitute, on the lines under the Administration of the State Railway, the switches are locked by a key, which is in the cabin, electrically locked from the station (compare answer to question 28). The Moscow-Windau Railway has centralized locking at stations with but little traffic, if the cost is less than that of centralized operation. The Weichsel Railway has about 3 per cent of all the centralized switches bolted.	At smaller stations where the switches have not be thrown over in making various routes; also at stations where there are but few trains.	Centralized locking has as yet been applied but rarely, and then only at stations where this system is limited to individual switches, or where for special reasons the local operation of the switch was preferred to operation from a distance.

QUESTIONS.	Summary of the answers. (Continued.)	
	Germany.	Austria and Hungary.
13. Up to what distance is such locking applied with success, and how long is the corresponding wire transmission?	Up to 500 or 600 metres (547 or 656 yards); with a travel of wire of 500 millimetres (1 ft. 7 11/16 in.). Such locking is even applied (Alsace-Lorraine), with good results, up to distances of 1,350 metres (1,476 yards), with the same travel of the wire.	Up to 550 metres (600 yards), with travel of wire of 500 millimetres (1 7 11/16 in). In Hungary, with the sam travel of wire, up to 500 metres (5 yards).
14. What arrangements are made in connexion with the switch locks, so as to make the cutting open of switches as little injurious as possible?	None.	None.
15. Do you consider it necessary to make arrangements in connexion with switch locks, so that if the locking transmission breaks, the switch is nevertheless kept locked and the setting of the signal is prevented? Have you already such devices in use?	Arrangements for keeping the switch locked if the locking transmission breaks are as a rule not considered necessary, but are partly considered desirable and have been applied in a few cases (Oldenburg). But when a locking transmission breaks the setting of a signal is prevented.	As a rule, no. The Kaschau-Oderbe Railway thinks such devices are to recommended, but it has not yet us any.
16. Have you any arrangements on your system in which a given position of the switch lever releases the switch so that it can be operated locally?	Only in very few cases (Baden).	No.
17. Do you still use single-wire transmission for signals?	No.	No.
18. Up to what distances, on approximately straight sections, do you consider double-wire transmission safe for the operation of signals under all conditions of weather?	Up to 1,200 to 1,500 metres (1,310 to 1,640 yards).	Up to 1,500 metres (1,640 yards).
19. What travel of wire do you use for the operation of signals?	As a rule, 500 millimetres (1 ft. 7 11/16 in). In Oldenburg, 400 millimetres (1 ft. 3 3/4 in.).	As a rule from 250 to 500 millimet (9 13/16 inches to 1 ft. 7 11/16 in.), accordi to the distance of the signals. On t Hungarian State Railway 500 mi metres (1 ft. 7 11/16 in.).
20. Do you operate the main and the distant signal with one double-wire transmission or with two separate transmissions and separate but interlocked levers?	Generally with *one* double-wire transmission and only in special cases (if there is much resistance, also at starting signals) two levers and separate wire transmissions. In Saxony however separate working with two interlocked levers is adopted as a principle. This change is now being adopted in Baden.	Nearly exclusively with two separ wire transmissions and with two in locked levers; only at the Hungar sections of the Southern Railway one double-wire transmission us

Summary of the answers. (Continued.)

Rumania.	Denmark.	Russia.	Sweden.	Switzerland.
nswer to question 12.	Up to 400 and 500 metres (437 and 547 yards), with a travel of wire of 500 millimetres (1 ft. 7 11/16 in.).	On the Moscow-Windau Railway, up to 550 metres (600 yards), (length of wire travel not stated); on the Weichsel Railway, up to 1,200 metres (1,312 yards), with a wire travel of 600 millimetres (1 ft. 11 5/8 in.).	Up to 600 metres (656 yards) (in one case), with a wire travel of 500 millimetres (1 ft. 7 11/16 in.) On the Stockholm-Rimbo Railway the greatest distance is 250 metres (273 yards).	Up to 800 metres (875 yards), on the Swiss Federal Railway without hesitation, with a wire travel of 500 millimetres (1 ft. 7 11/16 in.) On the St. Gothard Railway, up to 200 metres (219 yards), with a wire travel of 450 millimetres (1 ft. 5 11/16 in.).
	None.	As a rule, shearable bolts on the locking bars. On the lines under the Administration of the State Railway, at small stations at which the switches are locked by keys (compare Answer 28), there are shearable pins with electric control indicating the cutting open of the switch and locking the bar operating the signal.	On the State Railway, none. On the Stockholm-Rimbo Railway the transmitting disk at the axis of the lever is uncoupled by the cutting open of the switch.	None.
arrangements are not de, as switch locking not yet adopted: but y are considered necess-y, in case of such lock-, when purely-locking nsmissions are in ques-n, but only condition-ly, if the lock roller at the signal transmis-n.	No.	Arrangements of this sort, as far as switch signal locks are concerned, are considered desirable, but none are as yet used.	Arrangements for keeping the switch locked if the locking transmission breaks are as a rule not considered necessary, but the loking must be so arranged that if the locking transmission breaks it becomes impossible to set the signal to line clear.	Such arrangements are not considered absolutely necessary; up till now none are in use.
	No.	Generally no. Only on the Moscow-Windau Railway, at small stations, are there such switching arrangements.	Yes, rather extensively.	St. Gothard Railway: no. Swiss Federal Railway: yes. This refers to switches much used for shunting operations and difficult to supervise from the cabin.
	No.	No.	No.	No.
o 1,300 metres (1,420 rds). At present howe-only home signals h drop disk mechanic-y replaced (without any cial distant signals) used.	Up to 600 and 700 metres (656 to 765 yards).	Up to 1,500 metres (1,640 yards); on the Weichsel Railway, also up to 2,000 metres (2,187 yards).	Up till now 1,525 metres (1,668 yards) is the greatest distance.	Up to 1,000 and 1,200 metres (1,094 to 1,312 yards).
erly 450 millimetres ft. 5 11/16 in.), more ently 500 millimetres t. 7 11/16 in.).	500 millimetres (1 ft. 7 11/16 in.) for main signals, 250 millimetres (9 13/16 inches) for road signals.	Generally 450 and 500 millimetres (1 ft. 5 11/16 in. to 1 ft. 7 11/16 in.), but also less, down to 209·5 millimetres (8 1/4 inches).	As a rule 400 and 440 millimetres (1 ft. 3 3/4 in. to 1 ft. 5 5/16 in.).	Swiss Federal Railway: 500 millimetres (1 ft. 7 11/16 in.). St. Gothard Railway: 450 millimetres (1 ft. 5 11/16 in.).
e are nodistant si gnals.	As a rule with one double-wire transmission and only occasionally at greater distances with two levers and separate wire transmissions.	Both with a double-wire transmission as well as with two separate transmissions and two interlocked levers. In some parts distant signals are not used.	With one double-wire transmission.	With one double-wire transmission with a division and connexion at the main signal.

QUESTIONS.	Summary of the answers. (Continued.)	
	Germany.	Austria and Hungary.
21. In which cases have you electromagnetic interlocking of the signal and the wire transmission?	With section blocking nearly always in the case of the starting signals, at least for the through main lines and at the corresponding distant signals, in order to prevent, when trains succeed each other rapidly, two trains from starting immediately after each other on the same given signal; moreover in the case of group starting signals applying to departures by various lines; also in order to interlock two succeeding signals if operated separately (for instance starting and distant signal); also at the entrance signals and distant signals on lines *without* section blocking, which join in the open lines *with* section blocking (Saxony). Also in the case of multiple-arm signals, operated by one lever only (Alsace-Lorraine).	At starting signals, which at the sa time are the first signals of a sec blocking system; also at star signals for goods trains from sev tracks, in order to make it necess to operate the signal for each ind dual goods train. Also at electrica operated signals. In Hungary at starting signals of stations, which not protected by interlocking arr gements.
22. Have you made special arrangements so as to make more difficult or impossible any illicit operation of signal wire transmissions outside the cabins?	Apart from wooden or iron protective boxes, none.	As a rule no. The Southern Railv has, instead of stretchers, multiply or reducing levers in use, cove by wooden boxes.
23. In new constructions do you have wire transmissions operation without stretchers?	Only to a very limited extent. In the case of main signals, only if they are on gantries by the cabin. On the other hand, some distant signals up to a distance of 1,000 metres (1,094 yards), are without stretchers. (Wurtemberg), also shunting switches with a transmission less than 200 metres (219 yards) and signals with a transmission less than 400 metres (437 yards) long (Bavaria).	Yes, nearly everywhere without st chers. The Aussig-Teplitz Railv however only omits the use of st chers in the case of signal transi sions less than 200 metres (219 ya long. On the Hungarian section the Southern Railway the use stretchers is limited to distant sig which are a long way off.
24. Have you made any special provision, in order to counteract the disadvantages of the formation of ice at any exposed parts of the switch gear?	Yes, careful drainage of the ground under the transmitting and operating gear which is covered up, sufficiently large spaces between the latter and the ballast; channels and protective boxes wich are open below; openings in the deviation sheaves of the signals.	Yes partly. These disadvantages counteracted by protective cov over the sheaves, also by cases, box tubes, etc. The Hungarian S Railway does not mention any s devices.
25. If the signal wire transmission breaks, does the signal fly automatically to danger?	Yes (Wurtemberg excepted); in Bavaria by the weight of the arm itself.	Yes.
26. In new constructions, do you also use the signal wire transmission for the locking of movable installations (switches)?	Yes, but only to a limited extent. In Oldenburg and Saxony only for the safety locking of entrance switches, which are operated from a cabin at a considerable distance (in Saxony over 300 metres (328 yards).	No.
27. What is the greatest number of switch and signal levers which you have, with satisfactory results, combined in one frame, with hand operation?	Prussia: 87 levers. Bavaria: 90 levers. In Bavaria fewer levers are now preferred, if this does not involve any considerable additional expense.	Austria: 79 levers. Hungary: 40 lev

Summary of the answers. (Continued.)

Rumania.	Denmark.	Russia	Sweden.	Switzerland.
the case of section ocking at the starting gnals.	In the case of automatic return to "danger", or when it is desirable that a signal dependent on one cabin can also be set to "danger" from another point, or when several signal arms are to be operated by one lever.	In the case of electric section blocking at the starting signals, also at the "line clear" disks placed on the entrance signals and operated together with them; also at entrance signals.	In the case of section blocking at the starting signals; in cases this is as yet only intended.	At signals which are far apart, or at through signals placed close to the entrance signal and for which a special lever is not provided in the cabin.
	No.	Yes, locking gear at the stretchers. They are also protected by wooden boxes.	State Railway : no. Stockholm-Rimbo Railway : yes.	Yes.
	Yes.	Only very rarely. Occasionally at signals with wire transmission less than 200 metres (219 yards) long.	Only when the installation otherwise is not so arranged that if a wire breaks the setting of the signal to "line clear" is prevented. Then also in the case of locking when the transmission is shorter than about 100 metres (109 yards).	Swiss Federal Railway : no. St. Gothard Railway : only at distances of less than 200 metres (219 yards).
protective casings or otective covers over all e blocks and cranks.	Yes, these disadvantages are counteracted whenever necessary, by covering the stretchers, blocks, etc.	As a rule, no. Partly wooden protective casings.	Yes, as regards the most northerly parts.	Yes, on the Swiss Federal Railways all deviation blocks, stretchers, cranks and compensating levers, switch locks, etc., are protected by iron covers. The St. Gothard Railway does not mention any special provision.
	Yes, but this system is not universal.	Yes.	Yes, in all new installations.	Yes.
	Yes, for the control locking, where conditions make this possible.	Yes, but rarely	Yes.	Swiss Federal Railway : yes, for the control locking of switches. St. Gothard Railway : no.
evers (and space for more).	70 levers.	About 50 levers.	58 levers.	70 levers.

QUESTIONS.	Summary of the answers. (Continued.)	
	Germany.	Austria and Hungary.
28. Have you any devices in use, or in prospect, which are improvements in hand-operated installations, and which are not referred to in the previous questions?	No.	No.
29-47 : *Power operation.* (Power is used for the actual moving of the signal or switch.)		
29. Have you any signals or switches, in which the operation (the work of the actual moving) is effected by : *a*) Electricity; *b*) Compressed gas (compressed air); *c*) Water unter pressure (liquid under pressure), and the signalman only directs the operation?	Yes, the signals and switches are operated by electricity or compressed gas (compressed air or carbonic acid). Only a few installations of the latter kind are in existence. Operation by liquids under pressure is not used.	Yes, signals and switches are here o rated by electricity or compressed a In Hungaria there is yet only one su installation, and that with compress air.
30. In the case of electric operation of signals and switches, is the power supplied by means of electric motors (state whether continuous-current, single-phase or three-phase current), or by solenoids?	Preferably by continuous-current motors, but in some cases also by solenoids in the case of signals (Prussia).	By continuous-current motors.
31. Can the switches only be moved from one end position to the other, or can they also be moved back from intermediate positions? (Separate answers for cases *a*, *b* and *c*.)	Switches operated electrically or by compressed air can be moved back from intermediate positions. Only in older installations is this not the case.	In the case of the newer installatio switches operated electrically or compressed air can also be mov back from intermediate positions.
32. What is the average time required for throwing over a switch? (Separate answers for cases *a*, *b* and *c*.)	With electric operation 2-3 seconds, with compressed-gas operation 2-8 seconds, according to the distance of the switch and its system of construction.	2-5-4 seconds.
33. Can a switch which has been cut open be again put into normal condition from the cabin, or has this to be done at the switch itself? (Separate answers for cases *a*, *b* and *c*.)	In the newer installations, if a switch operated electrically or by compressed air is cut open, it can again be put into normal condition from the cabin.	In the newer installations, if a swit operated electrically or by compress air is cut open, it can again be p into normal condition from the cab

Summary of the answers. (Continued.)

Rumania.	Denmark.	Russia.	Sweden.	Switzerland.
erence is made to the l contacts, the time con- cts, the electric interloc- ng (including the route erlocking), which are use.	No.	In the lines under the Administration of the State Railway electric devices are used, so that at the cutting open of a switch the signal is at once set to danger. Then also at small stations the locking of the switches by keys, in stead of centralized switch locking, has given good results; the keys are kept in the cabin and released electrically from the station.	No.	No.

29-47 : *Power operation.* (Power is used for the actual moving of the signal or switch.)

er operation is not used.	Yes, by electricity. (At present the is only one such installation.)	Yes, chiefly by electricity. On the Weichsel Railway signals and switches are also operated by liquids under pressure (water in summer, paraffin in winter). They are also a few signals and alarms, which are operated by carbonic acid; some of them are experimental installations.	Power operation is not yet in use.	Power operation is not yet in use.
o.	By continuous-current motors.	By continous-current motors.	Ditto.	Ditto.
o.	The electrically-operated switches can be moved back from intermediate positions.	The electrically-operated signals can also be moved back from intermediate positions and also be moved forwards again.	Ditto.	Ditto.
o.	Two seconds on the average.	2 1/2-3 seconds in the case of electric operation. 3 seconds in the case of liquid under pressure.	Ditto.	Ditto.
above.	The electrically-operated switches can again be put into normal condition from the cabin.	As regards the installations on the lines under the Administration of the Russian State Railway the electrically-operated switches can again be put back into normal condition from the cabin. At regards the installations on the Warsaw-Vienna Railway, and the switches operated by liquid under pressure of the Weichsel Railway, putting back the switches into normal condition has to be done at the switch itself.	Ditto.	Ditto.

QUESTIONS.	Summary of the answers. (Continued.)	
	Germany.	Austria and Hungary.
34. Is the electric control of the position of the switch arranged so that it only checks the completion of the operation of the switch as a whole, or so that it checks the correct position of each of the two blades?	Both systems are in use. In the cases of switches taken by passenger trains from the facing side, it is usual to check the position of each of the two blades.	Both systems are in use. In the ne installations the control is so arran that the position of each of the blades is checked.
35. Do you operate all the switches concerned in a given route simultaneously (by the route lever), or do you limit the simultaneous operation to every two related switches, or do you have all the switches operated separately?	As a rule switches are operated separately; but two related switches are also operated simultaneously.	As a rule each switch is operated parately; simultaneous operation limited to two switches.
36. Has the simultaneous operation of several switches proved satisfactory?	As regards the mechanical installations, quite satisfactory; particulary if the two motors of the related switches are so connected that one works after the other.	The simultaneous operation of switches, having their motors coup up in parallel, has given rise to difficulty.
37. In the case of shunting operations, for which the route locking and the signals are not used, is the arrangement made that when several related switches are set simultaneously, the failure of one to attain its correct position, also prevents the moving of the others?	Not as a rule. In the case of the abovementioned successive working of the two motors, if the switch acted on first fails to attain its correct position, this also prevents the moving of the second switch.	No.
38. Have the power installations in use given satisfactory economical results or the reverse : *a*) as regards labour; *b*) as regards maintenance; *c*) as a whole?	As regards labour, economical advantages nearly in all cases; as regards maintenance, economical disadvantages, according to local conditions. In Wurtemberg, also, the maintenance has proved advantageous economically.	Economical results both as regards bour and as regards maintenance.
39. Have they facilitated the working of the service?	Nearly generally : yes. But Bavaria answers in the negative.	Yes.
40. Have they made it possible to effect a saving in staff, and to what extent?	In Prussia, this varies with the local conditions. In Alsace-Lorraine, as working-hours could be extended, a saving of about 20 per cent in labour was effected. In Wurtemberg from 1 to 2 men less are required at every cabin. In Bavaria and Saxony, none.	Austria gives no answer; as rega Hungary, yes, about one third.
41. Are failures more frequent or less frequent than in the case of hand-operation?	As a rule more frequent.	Rarer; certainly not more frequent.

Summary of the answers. (Continued.)

Rumania.	Denmark.	Russia.	Sweden.	Switzerland.
bove.	The control only checks the completion of the whole operation.	As a rule, only the completion of the whole operation of the switch is checked; but the system of checking the position of each blade separately is also in use. In the case of the switches operated by liquid under pressure there is no electric control.	See above.	See above.
bove.	Simultaneous operation is only used in the case of two related switches.	As a rule the switches are operated separately: two related switches are also operated simultaneously. In the case of the switches operated by liquid under pressure, separate operation alone is used.	See above.	See above.
bove.	No answer is given.	Very satisfactory; but as yet not more than two switches are operated simultaneously.	See above.	See above.
bove.	No.	There is no decided answer.	See above.	See above.
bove.	As a whole, economical results.	The electrically-operated installations (of which there is as yet but one on the Russian State Railway system) are simpler to operate, but require more careful maintenance: this however is an advantage from the point of view of the safety of the traffic. There is an economical advantage as regards the maintenance of the transmission. Disadvantages: great initial cost. Installations operated by liquids under pressure are all more costly.	See above.	See above.
bove.	Yes.	Yes.	See above.	See above.
bove.	The one existing installation is new; consequently the question can not yet be answered.	On the State Railway system: 25 to 30 per cent, when larger installations are considered. On the Warsaw-Vienna Railway and on the Weichsel Railway: no.	See above.	See above.
bove.	More frequent.	On the State Railway system, less frequently; on the Warsaw-Vienna Railway and on the Weichsel Railway, more frequently.	See above.	See above.

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QUESTIONS.	Summary of the answers.	
	Germany.	Austria and Hungary.
42. What kinds of failure occur most frequently?	Incomplete making of contacts in consequence of deformation or dirt; blowing of the fuses, fusing of cable wires of the motor leads, fracture of the contact springs; failure of the control of the blades, resulting from the pressure of foreign bodies at the blades or from movements of the track; burning-out of the field magnets and destruction of the insulating bushes. Trouble with the magnetic couplings and the charging apparatus. In the case of pneumatic operation: loss of tightness of the operating pistons.	Failures as a rule only occur with insulated rails. Wear of commuta and loosening of the terminal scre are also mentioned.
43. Does their correction take a longer or shorter time than in the corresponding failures in the case of hand operation?	As a rule less time, if the employee entrusted with the work is on the spot. In the case of smaller installations in Bavaria, more time. Alsace-Lorraine and Saxony state that sometimes considerable time is lost in trying to find the faults.	Shorter.
44. Is a specially-equipped mechanic kept on the spot to attend to the ordinary maintenance of the installation and to do smaller repairs, or does the usual permanent-way maintenance staff suffice for this purpose?	Specially-trained men (mechanics labourers) are kept on the spot, who have obtained the necessary experience (if possible, when the installation was constructed).	Specially-trained men are kept at larger stations; at the smaller o the ordinary permanent-way mai nance staff suffices.
45. Have you also, in connexion with hand-operated installations, equipped individual appliances which have to be set from a gret distance, for power operation, and with what success?	Yes, single signals with good success. Partly however this has only been done as an experiment, so that no opinion as to success can yet be given.	No.
46. What improvements in power installations do you consider desirable and practically possible?	No special improvements are described; but Alsace-Lorraine mentions as desirable the better protection of the appliances against dust and dirt, and the stronger construct on of the cases containing the motors, for more effective protection in cases of derailment. Saxony recommends that the power installations should be designed in such a way that simple-phase current can also be used.	(There is no answer from Austria.) The Hungarian State Railway has o one installation, of older constructi and is not in a position to mention improvements on those already at ned in the newer installations.
47. In the case of new constructions, to you consider the use of power installations, and to what extent? Which system do you prefer?	Yes, if in cases of much traffic the signalmen would be overworked in case of hand operation, or would have to be increased in numbers, at additional expense, and if electric power is available. Then also at large stations with many block sections and much traffic. At present the question is as yet partly undecided. Experiments made to determine whether installations operated purely electrically, or installations operated pneumatically but controlled electrically, are to be preferred, are not yet completed; but as a rule there is a tendency in favour of purely-electrical operation.	Yes, at stations with many block s tions and very much traffic, and stations where the construction maintenance of long transmission very difficult and costly. The electric system is on the whol be preferred. In Hungary the inv tigation of this question has not been completed.

Summary of the answers. (Continued.)

Rumania.	Denmark.	Russia.	Sweden.	Switzerland.
ove.	Failure of contacts, short-circuiting of the magnet windings, blowing of fuses.	Blowing of fuses; premature operation when vehicles are on the track; failure of the apparatus owing to defective insulation, to the formation of ice at the external electric contacts. When liquid under pressure is used: leakage of the water under pressure and dirt.	See above.	See above.
ove.	About as long.	State Railway system: as a rule shorter, because all the parts concerned can be renewed more easily. Warsaw-Vienna Railway and Weichsel Railway: longer.	See above.	See above.
ove.	A mechanic seems necessary in addition to the ordinary maintenance staff.	According to the experience of the Administration of the State Railway the ordinary permanent-way maintenance staff suffices, but must be well equipped. But both the Warsaw-Vienna Railway and the Weischel Railway keep a special mechanic.	See above.	See above.
ove.	No.	Yes, several signals which are very far off are operated by carbonic acid, and that with very good results.	See above.	See above.
ove.	That the moter should be freely accessible and above ground, and that the position of both blades of the switch should be checked.	Generally speaking no recommandations are made; the Warsaw-Vienna Railway however considers as desirable arrangements for automatically stopping a train at a main signal if this is standing at »danger«.	See above.	See above.
ove.	Yes.	As a rule, no. The State Railway, only in the case of large stations; and in such cases operation by electric motor (not solenoids) is taken into consideration.	See above.	See above.

QUESTIONS.	Summary of the answers. (Continued.)	
	Germany.	Austria and Hungary.
48-65 : *Signals and switches generally.*		
48. In which cases do you use electric controls for checking whether the operation of the signal has been carried out correctly?	Some managements use them at all signals which are at a considerable distance; but always when the signal is operated by power. In the case of hand-operation, as a rule, when the signalman cannot see the signal. Baden uses them for informing the general traffic office when a main signal has been operated from a signal cabin; also for the information of the signalman himself, if the main signal does not possess any coupling arrangement, the circuit of which is broken when the signal is lowered. Alsace-Lorraine uses these controls on all entrance signals, Saxony on main signals with long transmission, if the signalman cannot see them. Bavaria uses in the case of hand operation electric controls for checking the position of the signal lever, if the operation is not carried out under the supervision of the signal cabin; then also in special cases there are electric controls for checking the position of the starting signals.	When signals are not interlocked also cannot be seen by the signalm Then these controls are also specia used in the case of all entrance gnals, and in cases also for start signals. On the Hungarian St Railway such controls are used ge rally.
49. Does this control apply to the « danger » position of the signal, or does it also apply to the « caution », « proceed slowly », and « line clear » positions?	As a rule to the « danger » and « line clear » positions, in a number of cases to the « danger » position only. Exceptionally (in Bavaria, in cases of hand-operation) it is limited to the « line clear » position.	As a rule only to the « danger » positi (On the Hungarian lines of the A trian Southern Railway it also plies to the « line clear » position.)
50. Is there also such an electric control to show that the signal lantern is burning or is such an arrangement, in consequence of the experience gained, being taken into consideration?	No.	No.
51. Is the signal-control current, or its interruption, also utilized for locking purposes in the cabin?	No.	No.
52. Have successful attempts been made materially to increase the illuminating power of the signal lanterns as compared with the present average, and if so, in which way?	Yes, in Baden with reflectors 240 millimetres (9 7/16 inches; [instead of 150 millimetres (5 15/16 inches)] in diameter; and Saxony with special unsymmetrical reflectors. Further experiments are being made.	No.
53. In what cases do yon use specially-strong signal lights?	Specially-strong signal lights are as a rule not used. Baden alone is using them of base for distant signals.	In no case.

Summary of the answers. (Continued.)

Rumania.	Denmark.	Russia.	Sweden.	Switzerland.
48-65 : *Signals and switches generally.*				
rule at entrance and rting signals (the con- ls used are on the nk patent system, plied to Siemens & lske installations).	When the signal cannot be seen by the employee responsible for its operation.	Principally in the case of signals which can only be seen with difficulty, or not at all, from the signal cabin or by the employee operating the signal. The Warsaw - Vienna Railway uses such controls in the case of all main entrance and starting signals; the Moscow-Brest Railway, in the case of all centrally-placed signals.	Such devices are not used	In the case of all entrance signals, exceptionally also in the case of starting signals, which cannot be seen by the employee operating them.
ne « danger » and the ne clear » positions.	Only to the « danger » and the « line clear » positions.	Nearly exclusively to the « danger » and « line clear » positions.	See above.	In the case of older installations only to the « danger » and « line clear » positions; in the newer installations also to other intermediate positions.
	No.	As a rule, no. Only in the case of electrically-lighted signals, on the lines of the State Railway, are there control lights in the signal cabin.	See above	Only in the case of electrically-lighted signals. The Swiss Federal Railway only uses them in the Simplon tunnel.
	No.	As a rule, no.	See above.	No.
	No.	As a rule, no. On the Warsaw-Vienna Railway electrically - lighted signals have given good results; the experiments with acetylene lighting did not give satisfaction.	No.	On the Swiss Federal Railway, none. The St. Gothard Railway is beginning to replace its 10-line burners by 14-line burners.
are not used.	They are not used.	The Weichsel Railway uses them for entrance and for starting signals. The Warsaw-Vienna has as yet only made experiments.	It has never been necessary to use specially-strong lights.	In tunnels, especially under bad smoke conditions.

QUESTIONS.	Summary of the answers. (Continued.)	
	Germany.	Austria and Hungary.
54. Have you taken any special measures for preventing the fracture of the signal-light glasses ?	Yes, lead and rubber settings. The signal arms and disks are equipped with check springs and counterbalanced so as to reduce shocks. In addition wire glass is also used, especially for distant signals.	Yes, wire glass and elastic settin the glasses.
55. In case of failure, are the switches also arranged for hand-operation on the spot, and how : *a*) In the case of hand-operation? *b*) In the case of power-operation?	In most cases the only arrangement made is that a hand lever can readily be fixed on the spot. In Saxony the hand lever is already fixed, but disconnected from the switch. In cases of electric operation the motor can be turned by a cranked handle. In addition, in some cases (Sax hand levers are put up alongside, which can be quickly joined up afte electric gear has been disconnected. In the case of compressed-air operati hand lever can be fixed in cases of failures.	Yes, the hand lever can easil fixed.
56. Do you also operate from your cabins switches with blade but without heel chair (spring switches) ?	Yes, but partly (in Saxony, Wurtemberg and Baden) only as an experiment. Spring switches are not used in Bavaria.	Yes, experimentally on the Railway.
57. Are arrangements made to prevent any injurious action of the elastic force of such switches on the operating gear : *a*) In the case of hand-operation ? *b*) In the case of power-operation ?	Not in the case of hand-operation, but in some cases of electric operation there is an elastic friction catch, which holds the operating rod in its final position (trials in Alsace-Lorraine). In the case of electro-pneumatic operation the existing pressure of the air suffices.	No answer.
58. Do you also operate from your cabins barriers and level-crossing gates, and are they then included in the route interlocking ?	Yes, but as a rule only the barriers are included in the route interlocking.	Yes, but only the barriers are incl in the route interlocking, while l crossing gates are separately l locked with their signals. In the case of barriers locking is s times adopted instead of setting a distance.
59. Are any arrangements provided, by means of which the locomotive driver is specially informed : *a*) That he is approaching an optical signal ; *b*) That the optical signal he is passing is standing at « danger », or « caution », or « proceed slowly » ? This in addition to the appearing of these signals and the use of detonators placed by hand on the track. What are these arrangements ?	Yes, placing the detonators on the track by a lever machine. The appearing of several very bright lanterns. Contacts and impacts, which operate alarms and visible signals on the locomotive. (Experiments with the Braam signalling devices.) Gongs at the distant signals in places where there is much fog (partly already discarded).	No.
60. Do you in some cases, before the definite signal, provide means of communication in order quickly to give information to a train which has stopped (electric syrens, etc.), without the agency of a signal cabin or arrangements for connecting up a telephone line?	Yes, to transmit the signal « wait », electric systems are in some cases used (Prussia and Saxony).	No.
61. Are any means provided which make it possible to catch a train which is not stopping or probably is not going to stop at the spot it should stop at?	Yes, sand tracks and hydraulic buffer stops in Prussia. Sand tracks and experiments with double skids in Saxony.	Austria : no. Hungary : sand tr in a few cases.

Summary of the answers. (Continued.)

Rumania.	Denmark.	Russia.	Sweden.	Switzerland.
	Yes, wire glass.	Yes, wire glass and lead setting; also setting wholly in wire work; but such measures are as a rule not taken.	No.	Yes; the Swiss Federal Railway uses metal frames and in addition putty or leather settings. Experiments with wire-work settings did not give satisfactory results.
	Not in the case of hand-operation; in the case of electric operation by a hand lever after removal of the motor.	In the case of hand-operation, on the lines under the Administration of the State Railway, no; otherwise generally yes. In cases of electric operation, the motor can be turned by a cranked handle.	No.	On the Federal Railway, only in the case of a few of the older wire-transmission installations. The switch is the operated by a crank swung horizontally, which is connected with the operating gear by a pinion and bevel gear. On the St. Gothard Railway by the existing gear.
switches with rotating ades, fished, are used.	No.	No.	No.	No.
56.	Spring switches are not used.	There are no spring switches.	There are no spring switches.	There are no spring switches.
barriers are included the route interlocking.	Yes, in a few cases.	As a rule yes, but generally only the barriers are included in the route interlocking.	Yes, the barriers are always included in the route interlocking, the level-crossing gates only rarely.	Yes, but as a rule only the barriers are included in the route interlocking.
	No.	No (apart from detonators).	No.	No.
	No.	No.	No.	No.
	Yes, sand tracks under special conditions.	Yes; for trains, sand tracks; for separate vehicles centrally-placed skid blocks and throw-off switches. Reference is also made to hand signals and detonators.	No	o.

QUESTIONS.	Summary of the answers. (Continued.)	
	Germany.	Austria and Hungary.
62. Do your trains automatically act on the signalling and switching gear? *a*) Advice of its approach? *b*) Blocking or unblocking action (apart from the measures considered under B)?	*a*) Only in solitary cases, by means of rails contacts. *b*) Yes. The passage over rail contacts either affects the block fields and unlocks them or the current is interrupted in the case of the signals fitted with gear for automatically flying to "danger".	*a*) As a rule not. Only the South Railway uses for the purpose appa tus and alarms for notifying approach. *b*) Yes. The passage over rail conta releases the magnetic locking o block field, so that it can then be c rated. The Southern Railways also in a few cases track-block appliances, which after the train passed an entrance signal blocks line until the entrance has been c pleted, and only allow the signal be set to "line clear" after the tr has departed. On the Kaschau-Od berg Railway the train exercice releasing action on the switching signalling gear.
63. What arrangements are made to make the setting of a signal to "line clear" dependent on the co-operation of the traffic manager?	As a rule releasing gear, which has either to be operated by the traffic manager himself or acted upon by interlocking. Prussia and Oldenburg very frequently use for this purpose keys, with which the traffic manager unlocks the corresponding field of release. In Saxony the so-called "assenting contacts" (Zustimmungskontakte) are in use, by means of which the traffic manager completes the circuit for the electric locking of the correct route, and at the same time makes it possible to set the corresponding signal to "line clear".	As a rule, releasing appliances wh have to be operated by the tra manager himself.
64. What arrangements have given the best results, in cases where many shunting operations are carried out, for obtaining a mutual understanding between the different inclines and the switches of the corresponding sorting sidings?	Mechanically-revolved large shunting disk indicators, with numbers on them; loud-speaking telephones, electric track indicators. In Bavaria there are also used disks with inscription hung on to the buffers.	In Austria, as a rule, special arran ments of this kind are not in use. Aussig-Teplitz Railway alone us in addition to the usual hand and h signals, special tickets, hand bells alarm signals. In addition, the p sage of the switch-limit marks of sorting sidings is indicated in signal cabin, by ringing special con bells, which are put into circuit by passage over special rail contacts. On the Hungarian State Railway, e tric indicators are used as track in cators.
65. Have you recognized as desirable, or tried, or taken into consideration, any further improvements in switching and signalling appliances besides those considered here; and if so, which?	Generally speaking, no.	No.

A. — II.

66-77 : *Electric interlocking of route levers.*

66. Do you principally use mechanical or electrical interlocking of the route levers?	Chiefly electrical interlocking. In Wurtemberg chiefly mechanical interlocking. In Bavaria at small stations up to distances of 400 metres (437 yards), mechanical, and at greater distances electical interlocking.	Chiefly electrical interlocking.

Summary of the answers. (Continued.)

Rumania.	Denmark.	Russia.	Sweden.	Switzerland.
). s. The passage over eadle sets the entrance ials mechanically to nger".	*a*) In some cases. *b*) Yes, to set free route levers and blocks.	Yes. *a*) By optical and acoustical signals sent to the signal cabin or station. *b*) By releasing routes and the locking of block fields: rail contacts and, experimentally, treadles. On some of the railways arrangements for this purpose are not provided.	*a*) Yes. *b*) Yes, to release blocks and the electric locking of route levers.	No.
e 1900, mechanical ises; after 1900 alter-ng-current block ap-tus for the electric se of the signals.	Electric interlocking gear	As a rule releasing appliances, which have to be operated by the traffic manager himself.	At smaller stations no special arrangements are made. At larger stations electric interlocking gear is used. Trials with mechanical interlocking gear did not give satisfactory results.	On the Swiss Federal Railway there is, as a rule, mechanical release of the route; on the St. Gothard Railway the consent of the traffic manager is, if necessary, obtained by telephone.
hones.	Loud-speaking telephones.	On the lines under the Administration of the State Railway and on the Warsaw-Vienna Railway loud-speaking telephones are used; the former also uses needle indicators. The Weichsel Railway uses for this purpose the ordinary optical and acoustical signals.	Such do not exist at shunting yards.	The understanding is arrived at by writing the number of the sorting siding desired on the buffer, or else verbally.
	At present not.	Generally speaking, no.	No.	No.

A. — II.

66-77 : *Electric interlocking of route levers.*

nical interlocking by ng, released electri-(by alternating-cur-fields).	Mechanical interlocking by slotting, released electrically.	Chiefly electric interlocking. The Ssysrau-Wjasma Railway chiefly mechanical.	Chiefly electrical interlocking.	Chiefly mechanical and only exceptionally electrical interlocking.

QUESTIONS.	Summary of the answers. (Continued.)	
	Germany.	Austria and Hungary.
67. Are only the entrance-route levers interlocked, or also the departure-route levers?	The entrance-route levers nearly all; frequently both. In Prussia, the departure-route levers only partly. In Oldenburg, only the entrance-route levers.	Both.
68. Is the electric interlocking of a route effected by the signalman by a separate operation, or does it result automatically from the operation of the levers?	As a rule by the signalman by a separate operation; but also automatically, as in Baden and to some extent in Bavaria. In the case mechanical station blocking automatically; the same in the case of power-operation.	As a rule by the signalman by a separate operation. On the Austrian Railway exclusively automatica the case of power-operation.
69. In the former cases, is the signalman compelled to carry out this operation, and if so, how?	Yes, the electric interlocking of the route lever has as a rule to be effected before the signal can be set to « line clear ». The compulsion to interlock electrically the route lever in the « danger » position, which presents the operation of the signal, is effected either by the interlocking of the block sections or by the signal moving automatically to « danger ». Another compulsion exists in the interlocking with the traffic-manager apparatus.	Yes, the electric interlocking o route has to be effected befor signal can be set to « line clear »
70. Do you use for this interlocking continuous-current or alternating-current apparatus? When the one and when the other?	Chiefly alternating-current apparatus; in Wurtemberg only continuous-current apparatus. Prussia, in the case of power installations, uses continuous-current interlocking apparatus.	In the case of hand-operation, alt ting-current apparatus, in the ca electrical operation, continuous rent apparatus.
71. Do you use electric interlocking of the route levers also in the « line clear » position in order to prevent the premature operation of switches?	Yes. (See also 69.)	Yes.
72. How and from where is this then released, and do you also let such interlocking be released by the train automatically?	As a rule by means of a special alternating-current (releasing) field after the arrival or departure has been completed. The release is effected from the station or from a cabin. Automatic release by the train is also used, in Wurtemberg and Alsace-Lorraine exclusively.	As a rule by the traffic manage means of a special alternating-cu (releasing) field. On the Southern Railway automat lease by the train is also used.
73. Have you any arrangements which make it possible to interlock groups of several route levers by one common appliance?	Yes, but not generally. But the interlocking of routes which mutually exclude each other is often effected by one common appliance. In Saxony such common interlocking appliances (groupe blocking) are used extensively.	Austria : yes. Hungary : no.

Summary of the answers. (Continued.)

Rumania.	Denmark.	Russia.	Sweden.	Switzerland.
.	According to the conditions, both.	Both.	Both.	Both. On the Federal Railway the entrance-route levers are mechanically interlocked in both the « line clear » and the « danger » position. The interlocking in the « line clear » position is effected by a special locking field, which is released by the passage of the train.
interlocking is effected tomatically by the moment of the lever.	Both system are used.	As a rule by the signalman by a separate operation. On the lines under the Administration of the State Railway and on the Weichsel Railway both systems are used.	As a rule by the signalman by a separate operation.	As a rule, automatic interlocking resulting from the operation of the lever.
nswer 68. See also 72.	Yes, the interlocking of the route has to be effected before the signal can be set to « line clear ».	Yes, the interlocking of the route has to be effected before the signal can be set to « line clear ».	In the case of electric interlocking of the route, this has to be effected before the signal can be set to « line clear ».	The Federal Railway gives no answer. The St. Gothard Railway has no such arrangements.
rnating-current apparus.	Continuons-current apparatus if the interlocking is mechanical or automatic; otherwise alternating-current apparatus.	Chiefly alternating-current apparatus. On the lines under the Administration of the State Railway, in the case of electrically-operated installations, continuous-current apparatus is also used.	Chiefly alternating-current apparatus. The State Railway however uses continuous current for interlocking the route lever for the « line clear » position; this is automatically released by the train.	On the Federal Railway, alternating current exclusively is used in the case of electric station interlocking; continuous-current is only used in the case of blocking fields which are automatically released by the train. The St. Gothard Railway has only continuous-current apparatus.
	Yes.	Yes.	As a rule, no. Up till now the State Railway has only one such apparatus, but several more are planned.	Federal Railway : yes (see 67). St. Gothard Railway : no.
ays by the train mana- by means of a special ernating-current (re- sing) field.	As a rule by the train, sometimes by the station-master.	As a rule by the traffic manager; sometimes (Warsaw-Vienna Railway) in conjunction with action by the train. On the Moscow-Windau Railway and on the lines under the Administration of the State Railway automatic release by the train is also in use.	As a rule by the train; only in one case by the station-master.	(No answer.) Note : According to answer 67, the release in the case of departures is effected by the train.
	Yes.	As a rule, yes.	No.	Federal Railway yes. St. Gothard Railway : no.

QUESTIONS.	Summary of the answers. (Continued.)	
	Germany.	Austria and Hungary.
74. Do you combine with route-lever operation the closing of any contacts, and if so for what purpose?	Yes, for closing the circuit of the battery through electrical coupler and electrical blocks; also for effecting the continuous-current route interlocking; for other interlocking; for completing the circuit, in group blocking, which has partly been made by the traffic manager or by the second signalman.	Yes, for closing the circuit of the ductor switched in by the tr manager, as well as for closing circuits which are required for given route.
75. Have you any electric interlocking of signals or switches which is effected without the action of the route lever?	Apart from block section signals, only exceptionally or in older installations. It is proposed in Prussia to introduce such interlocking in cases of power-operation.	Yes, but generally only in cases w the signals are not directly interlo with the switches, or in cases of simple installations.
76. Has the *a*) electrical, *b*) mechanical, route-interlocking used given good results, and does it also seem suitable for a very busy traffic?	Electric interlocking has proved satisfactory, particularly also for a very busy traffic, and is generally preferred to mechanical interlocking. The latter has, it is true, also given satisfactory results on the whole, but is not, in Prussia for instance, to be used in the future.	The electric interlocking used ne everywhere has given good and r ble results. On the Aussig-Te Railway, mechanical route-interl ing has also proved sufficient at tions with switch interlocking a gements.
77. What system of route-locking, or what arrangements for replacing it, would you recommend in the case of new installations?	As a rule, electrical interlocking. Satisfactory results have also been obtained (Bavaria) by automatic locking produced by the operation of the route lever.	A a rule, the usual (electric) i locking.

B.

78-94 : *Measures taken to prevent the operation of switches, whether taken from the facing or fr the trailing side, before the whole of the train has passed over them.*

78. Have you put in any devices of a purely mechanical nature, to prevent the moving of switches before the whole of the train has passed, *a*) when taken from the facing side; *b*) when taken from the trailling side: and of what kind are they?	Yes, as a rule pressure or contact treadles, particularly in the case of switches taken from the facing side. In Bavaria these mechanical devices have recently been replaced by electrical devices. Prussia and Oldenburg also use time locks for this purpose.	Austria: yes, pressure treadles in case of switches taken from the fa side; these are however no lo used by the Austrian North Wes and South Northern. The Au Teplitz Railway also uses pres treadles with special lever for d mining that the track is clear a switch-boundary mark. Hungary: No.
79. Are there any devices in use, which as soon as the first wheels pass on to the switch, lock it for a certain time, and after this time has elapsed, release it again?	Yes, time locks. Time locks which were used in Saxony and Baden as an experiment were removed owing to technical and operating difficulties.	As a rule, no.
80. Are mechanical devices (pressure or contact treadles, running rails with canting motion, etc.) used in combination with the electrical?	Yes, in individual cases, to form a substitute for an insulated rail. Pressure treadles are in use combined with rail contacts and continuous-current locking fields; electric lever locks at the treadle levers; canting rails acting on electric contacts to release blocking.	As a rule, yes. The Austrian N Western and South Northern pressure and contact treadles, in bination with insulated rails; Southern Railway contact tre rails. The Hungarian State Railway are using such devices experimentall

Summary of the answers. (Continued.)

Rumania.	Denmark.	Russia.	Sweden.	Switzerland.
or closing the circuit e battery through the rical coupler, and establishing the cor- circuits in the case oup blocking.	Yes, for instance for the electric interlocking of signals.	Yes, for signals contacts, insulated rails, coupler circuits; for changing the block field circuits; also in order to reduce the number of electric conductors, and to check the correct making of the route.	Yes, for the electric couplers at the starting signals in cases of section blocking, also for interlocking the route lever by means of a continuous-current field.	Federal Railway: Yes, occasionally for trough routes. St. Gothard Railway: No.
	Yes, in a few cases.	On the State Railway this is only used for signals; on the Weichsel Railway only for minor installations. Otherwise not.	No.	No.
	As yet there is not enough experience, but the question will probably be answered in the affirmative.	Electrical interlocking has proved advantageous. The Ssysran-Wjasma Railway uses mechanical interlocking exclusively, which works well.	The State Railway has as yet not enough experience. The Stockholm-Rimbo Railway answers the question, as far as electrical route-interlocking is concerned, in the affirmative.	Yes, both kinds of interlocking have given good results and satisfy stringent requirements.
Bruchsal system of truction is recom- ded.	The subject is here still in the experimental stage.	Electric interlocking. (The Siemens and Halske gear is specially recommended.)	As yet there is not enough experience.	The Federal Railway gives no answer. The St. Gothard Railway gives electric interlocking the preference.

B.

-94 : *Measures taken to prevent the operation of switches, whether taken from the facing or from the trailing side, before the whole of the train has passed over them.*

f required contact lles and also time are used (see 28).	Yes, contact treadles as an experiment in the case of switches taken from the facing side.	As a rule, no. Experiments made by the Warsaw-Vienna Railway did not prove satisfactory. The Weichsel Railway uses treadles.	Yes, contact treadles or so called treadle rails in the case of switches taken from the facing side. The State Railway also uses time locks for this purpose.	Federal Railway: Yes, contact or pressure treadles, also time locks (pneumatic), in the case of switches taken from the facing side. St. Gothard Railway: pressure treadles are being tried experimentally in the case of switches taken from the facing side.
ime locks at those hes at which contact lles can not be used.	Yes, experimentally.	Yes, on the State Railway insulated rails, on the Weichsel Railway time locks.	Yes, on the State Railway; time locks.	Time locks (pneumatic), only on the St. Gothard Railway, as an experiment.
	No.	As a rule, no; on the Warsaw-Vienna Railway only experimentally.	No.	In some cases of the route locking, balanced contact rails connected with the electric lever locks.

QUESTIONS.	Summary of the answers. (Continued.)	
	Germany.	Austria and Hungary.
81. What do you consider the correct length of the pressure or contact treadles?	11 metres (36 ft. 1 in.), occasionally more. In Saxony, 13·5 metres (44 ft. 3 1/2 in.); in Wurtemberg 15 metres (49 ft. 3 in.).	Generally 10 metres (32 ft. 10 in.) given as the correct length. T Aussig-Teplitz also uses treadles fr 6 to 12 metres (19 ft. 8 in. to 39 ft. 4 i long, according to the wheelbase of t vehicles. The Hungarian State Ra way pronounces in favour of lengt exceeding 12 metres (39 ft. 4 in.).
82. What lengths have already proved satisfactory from the point of view of construction?	Lengths of 11 metres (36 ft. 1 in), also of 13·5 metres (44 ft. 3 1/2 in.) (Saxony) and 15 metres (49 ft. 3 in.) (Wurtemberg).	Lengths of 10 metres (32 ft. 10 in Under some conditions lengths 7 metres (23 feet) suffice and pro satisfactory. In any case the leng must at least be equal to the great standard wheelbase. In Hungs there is as yet not enough experienc
83. Have such treadles also been used with good results at curves?	Yes, with good results at curves with diameters down to 300 metres (15 chains); in a few cases with results which only just sufficed, down to 180 metres (9 chains). Some managements do not use them on curves.	Yes. According to the experience of t Austrian Southern Railway they ho ever require more frequent inspe tion, as rail-creeping easily produc jamming.
84. Are also purely-electrical devices in use for the same purpose?	Yes, in the case of power-operation, insulated rails (by themselves or in combination with rail contacts before the switches, and when the train passes on to the former, the switch lever is locked; in the case of hand-operation the route rod is locked by an electric block field. Alsace-Lorraine also uses for the purpose the electric lever lock at the switch or the route lever. Bavaria in more recent times uses the same locking gear also to release the route, in combination with a mechanically-acting wheel contact.	Yes.
85. How is it arranged, that the action does not terminate before the last axle has passed; for instance if the train stops?	By the use of insulated rails or by having a corresponding distance between the switch and the rail contact before it.	By the use of insulated rails or having a corresponding distance b ween the switch and the rail cont in front of it.
86. Do you also use insulated rails for this purpose?	Yes, but not generally.	As a rule, yes.
87. Do you also use insulated rails for other purposes, and if so, which?	Besides the chief purpose, which is to maintain the route locking or the switch locking until the train or vehicle has left the insulated rail, they are also used for the release of electric blocking keys or block fields, also for releasing electric signal-arm interlocking. In Wurtemberg the insulated rail is also used for indicating the departures of trains.	Yes, in the case of section blocking a for releasing routes. In addition th are also used by the Austrian Sou ern Railway for locking the entra route till the entrance has been co pleted and in order to prevent release of the same signal, till af the train has left; also to oper indicators and bells notifying approach of a train.
88. What system of fishing has given the best results with you?	As a rule wooden fishplates made of hornbeam or of Australian hardwood with special stops for preventing creeping. In Saxony the action of the wooden fishplate is reinforced by a short longitudinal sleeper of oak supported on iron transverse sleepers.	As a rule, wooden fishplates of ho beam. On the Austrian Southe Railway, wooden framing under joint has also given good results.

Summary of the answers. (Continued.)

Rumania.	Denmark.	Russia.	Sweden.	Switzerland.
res (36 ft. 1 in.).	Experiments in this direction have only just begun.	10 to 11 metres (32 ft. 10 in. to 36 ft. 1 in.). As yet experience is limited.	The length must exceed the longest wheelbase.	Lengths of 12 metres (39 ft. 4 in.) are considered sufficient.
ıs of 11 metres (36 ft.).	See supra.	Lengths of 11 metres (36 ft. 1 in.). As yet however experience is limited.	Lengths of 13·5 metres (44 ft. 3 ½ in.).	Lengths of 12 metres (39 ft. 4 in.). But the question is not yet quite settled.
large-radius curves, e treadles are placed the superelevated	See supra.	No.	(No answer).	Contact treadles at curves do not seem advisable, hence are not used.
	Yes.	Yes, generally, such as : insulated rails, rail contacts, electrical locking apparatus for locking the switch or route levers.	Yes, rail contacts combined with continuous-current apparatus for locking the route lever in the route position (see 70).	Yes, rail contacts combined with continuous-current apparatus for locking the route lever in the route position. (See Nos. 67, 89 and 90.)
electric connection veen the rail contact the switch lever.	Special means for this purpose, those mentioned under 86 excepted, are not used.	By the use of insulated rails or of correspondingly-advanced rail contacts.	(No answer).	(No answer).
	Yes.	Yes, but not generally.	(No answer).	No.
n the case of section king, for departing ıs.	Yes, in order to prevent the premature throwing-over of switches and in connexion with rail contacts to release route levers and locking keys.	On the systems of the State Railway and of the Warsaw-Vienna Railway they are used for releasing routes, in the case of the former also for releasing the operation of block sections.	Special rails (insulated rails ?) are used in Sweden, together with bent-rail contacts for the release of the gear which locks the route levers in the position for the route. It is also proposed to use insulated rails for releasing electric couplings at starting signals in the case of section blocking, which is going to be introduced.	No.
sual wooden fishpla-	Wooden fishplates of Messrs. Siemens & Halske.	Wooden fishplates (pickled).	Enough experience is not available.	Insulated rails are not used.

QUESTIONS.	Summary of the answers. (Continued.)	
	Germany.	Austria and Hungary.
89. When special rail contacts are used, how does the train make and break the contact?	The rail bending under the train load causes mercury to make connexion, or break it, between the earthed casing and the conductor.	By bending the rail. (There is answer from Hungary.)
90. Do these electrical devices only serve to warn the signalman or do they lock levers?	In some cases, for warning only; but principally for releasing the levers and the other locking gear.	They chiefly are for locking and leasing the levers and locking of the cabins.
91. Have you also taken into consideration other devices for this purpose, or tried them already with success?	No (apart from the lever locks already mentioned).	As a rule, no. On the Austrian N Western and South-Northern sw control locks are used, dependin the mechanical and electrical r locking gear.
92. To what extent do you consider the introduction of such devices desirable and practically realizable, in cases of switches taken : *a*) From the facing side; *b*) From the trailing side?	*a*) The general opinion is that such devices are desirable for all switches taken by trains from the facing side. *b*) As a rule there is no need; only perhaps in those cases in which the switch cannot be seen well from the cabin and has to be operated (where there is a busy shunting service), immediately after it has been passed.	*a*) As a rule only for switches t from the facing side; partly als switches which can neither be centrally, nor locked. Partly als and (*b*) for those which can be centrally, but at a greater dist (about 250 metres [273 yards] and wards) from the cabin or cannot be seen from there.
93. Have these devices in any way given rise to any difficulties in the service or in their maintenance?	Not of any importance. They facilitate the service. They must be carefully kept up-to-date, but this presents no difficulties.	As a rule none worth mention On the Austrian North-Western South-Northern sometimes by cutting open of switches fitted control lock. In Hungary, none.
94. Which devices are you going to prefer when making new installations?	Treadles, rail contacts, also time locks when switches are only locked singly; electric route locking when several switches are locked for the passage of one train. Alsace-Lorraine also speaks in favour of insulated rails with rail contacts in connexion with the locking of levers.	As a rule treadles and insulated r according to the conditions. The Austrian Southern prefers, a ger stations where the block sy is used. electro-mechanical co treadle rails, at smaller sta pressure treadles, and at swi not otherwise protected Schi treadle rails. (The answer for Hungary is miss

C.

95-103 : *Graphic representation* of the occupation of the platform tracks at busy stations, and their use in case of any alterations in the service.

95. Have you, in order to facilitate the management of the traffic at busy stations, used graphic representations for showing the occupation of the tracks?	Yes, in a few districts. Partly there are only indicating plates (Wurtemberg, also coloured fields on the block apparatus together with the arrangement or the so called "occupation" interlocking or route interlocking (Bavaria. Baden). All these show if tracks are occupied.	As a rule, no. However there a use, in some cases, the diagram track representations (which ar stations) with movable buttons, w show in the case of arrivals, a that of departures that it is goi be free.

Summary of the answers. (Continued.)

Rumania.	Denmark.	Russia.	Sweden.	Switzerland.
corresponding answer issing.)	By bending the rail.	By bending the rail and making a mercury contact.	By the bending of the rail.	By the bending of the rail making a mercury contact.
affect the cabin	They are used for both purposes.	Partly for warning the signalman, partly for locking and partly for releasing. Chiefly the latter.	(No answer.)	Exclusively for locking or releasing levers or locking gear.
	No.	No.	No.	No.
switches taken from trailing side. ome cases of shunting rations, when the ches are at a greater ance from the cabin.	Chiefly for switches taken from the facing side, which cannot well be seen from the cabin.	Only in cases from the facing side; in mechanically-operated apparatus also, only in special cases.	*a*) For switches which must be thrown over immediately a train has passed. *b*) Such do not as a rule seem necessary.	(No answer from the Federal Railway.) The St. Gothard Railway thinks it advisable to have them in the case of switches which are not visible from the cabin and which are taken from the facing side by trains.
he time locks.	Not in the service. Difficulties in maintenance appear to occur particularly in the case of insulated rails.	None worth mentioning.	In the north of Sweden the treadle rails require careful and accurate supervision, when there is snow and ice. Therefore they are not suitable for such climatic conditions.	In the opinion of the St. Gothard Railway, time locks are not suitable in the case of stations where many shunting operations are carried out, as when this system is adopted too much time is lost.
ocking rails.	Sufficient experience is lacking.	Interlocked rails and time locks.	Sufficient experience is not available.	Uncertain.

C.

95-103 : *Graphic representation* of the occupation of the platform tracks at busy stations, and their use in case of any alterations in the service.

No.	No.	No.	No; but on the Swiss Federal Railway most of the cabins are equipped with automatic indicators showing the occupation of the tracks.

QUESTIONS.	Summary of the answers. (Continued.)	
	Germany.	Austria and Hungary.
96. In the case of these graphic representations, is the occupation of the tracks, according to the service, marked on them definitely, so that they only serve to facilitate a general view and make it easier to see the effect of any alterations?	Yes, except in the case of the devices with movable indicators mentioned under 95, in the case of Wurtemberg, Bavaria and Baden.	Graphic representations other those mentioned in the answe question 95 are not used.
97. Or are there movable marks, to indicate the occupation of the tracks, so that they can quickly be ajusted in accordance with the changing conditions as they are notified?	As a rule, no. There are exceptions in Wurtemberg, Bavaria and Baden See under 95.	As above.
98. Or are these marks moved simultaneously with the notifications received from ouside, either by the employees in charge or by the trains themselves?	No.	As above.
99. Or are these marks set by the traffic manager before the track is occupied, the setting serving as permission for the train movement in question?	No, unless the setting of these marks is in connexion with the system of blocks or, as in Wurtemberg, where indicating plates, as in Bavaria, where interlocked indicators are used and in Baden, for route interlocking (see 95).	As above.
100. Or are there any other relations between the graphic representations and the trains movements and the occupation of the tracks concerned?	As a rule not. In Bavaria and Baden, the devices mentioned above with the chief signalling or other cabin closes the entrance to a track which is occupied.	As above.
101. Does this representation of the occupation of the tracks also extend to shunting operations and to locomotives running light?	Only in solitary cases.	As above.
102. In this representation of the occupation of the tracks also extended to other than platform tracks? To what extent?	As a rule on all entrance and departure tracks, in so far as any representation exists.	As above.
103. Have such arrangements, and which, proved to be valuable as regards facilitating the service and as regards safety?	Yes, graphic representations have proved particularly valuable when special trains have to be intercalated. Similarly the indicating plates, the interlocked indicators and the route series have proved useful.	As above.

Summary of the answers. (Continued.)

Rumania.	Denmark.	Russia.	Sweden.	Switzerland.
hic representations to w the occupation of tracks are not used.	Graphic representations to shew the occupation of the tracks are not used.	Graphic representations to show the occupation of the tracks are not used.	Graphic representations to show the occupation of the tracks are not used.	Graphic representations to show the occupation of the tracks are not used.
bove.	As above.	As above.	As above.	As above.
bove.	As above.	As above.	As above.	As above.
bove.	As above.	As above.	As above.	As above.
bove.	As above.	As above.	As above.	As above.
bove.	As above.	As above.	As above.	As above.
bove.	As above.	As above.	As above.	As above.
bove.	As above.	As above.	As above.	As above.

1-28 : Hand-operated apparatus.

Operation of switches.
Questions 1, 3, 10, 5, 11, 8, 6, 9, 7, 16, 2.

The experience of half a century, on which the design of the newer hand-operated apparatus is based, has it is true resulted in a desirable comprehension of some of the questions involved in the design, and have led to more or less uniform practice; but on some important points opinions still differ very much. In the first place here is the question, whether switches at a distance are to be operated by means of rodding or by a double-wire transmission (1) [1]. During the last twenty years, wire transmission has become materially extended in the countries this report is dealing with. Germany has adopted double-wire transmission for the operation of switches in the large majority of cases, and Austria-Hungary has adopted it exclusively. Similarly in Denmark, Russia and Sweden, when new installations are in question, double-wire transmission is almost the only system adopted. On the other hand, rod transmission is preferred by the Alsace-Lorraine State Railway, the Baden State Railway, the Rumanian State Railway, the Ssysran-Wjasma Railway and the Swiss railways. The decision of the question, which system of transmission is the best, is not one which is within the scope of this report. It may, however, be pointed out that the chief disadvantage of rod transmission (giving no indication at the station if the continuity of the rodding is interrupted) is only of practical importance in exceedingly rare cases; and that on the other hand, the risk of fracture of the wire, and the defects of the appliances designed to make this harmless have not, in the many applications of this double-wire transmission made, proved so serious that it has been necessary to consider this system of transmission (which is advantageous from many points of view) as unsuitable or even as less suitable.

The new and decided position recently taken by some administrations in favour of rod transmission, has drawn fresh attention to this question; so also has the favourable verdict of the Bruchsal Works, who are very important manufacturers of signalling apparatus. The interest in consequence taken in the subject can be but an advantage from the general point of view. More especially does it have the effect that those in favour of wire transmission are not content with leaving matters as they are, but are observing and testing the reliability of the automatic safety appliances (to act if a wire breaks) under the most varying conditions, and are striving to obtain by stricter supervision and more careful maintenance the results which it is not yet possible to obtain by improved design. In the case of wire-transmission equipments, there are many great technical differences, which show that there is ample scope for the work of designers. In Germany, equipments with stretchers and cuttable switch locks, for the points separately, are most usual; while in Austria-Hungary there are generally no stretchers, but bolts for both points

[1] The numbers inserted in the text in brackets represent the index numbers of the questions which are being considered.

simultaneously, with shearable pins at these bolts. In the former country, wire ropes are generally used at the deviation blocks; in the latter, chains are preferred. It cannot be denied that the wire ropes at the deviation blocks form parts more liable to fracture than the wire transmission proper, on the guide blocks. There is a risk of fracture, after a few years of use, even in the case of the best wire ropes. According to the tests made by the Saxon State Railway, a good steel-wire rope having an effective cross-section of 9·6 square millimetres (189,460 circular mils), with the wires laid around a hemp core, can stand about 50,000 to 120,000 forward and backward movements, when forming an S shaped curve round two deviation blocks and subjected during the test to a tensile force of 150 kilograms 330 lb.).

It is intended in future to use an effective cross-section of 9 square millimetres (177,600 circular mils) and to specify that the rope must stand 100,000 forward and backward movements.

The signalling system of the Saxon State Railway has experienced, between 1 January 1908 and 1 April 1909 (1), the following fractures of wire transmission operating switches and signals :

2,875 switches with wire transmission : no true wire fractures, but 64 fractures of wire ropes;

3,688 signals with wire transmission : 3 fractures of wires and 103 fractures of wire ropes;

603 switches with rodding : 2 fractures of rodding and 1 fracture of a crank.

In the cases of the wire and wire-rope fractures which occurred, four signals remained in the position " line clear " and at one switch the lock did not act. That the signals did not automatically fly to danger, was caused in two cases by snow which had accumulated, and one case by the sticking of a soldered part, and in one case by the fact that part of the wooden protective casing interfered with the free movement of the counterweight. That one of the switch locks failed was also caused by the sticking of a soldered part; thus this was a fault in the construction, for if the dimensions of the different parts had been properly proportioned, this could not have occurred. Now although in consequence of the automatically-acting safety appliances, the fractures of wire ropes only result in a dangerous state of affairs in the rarest cases, yet the number of fractures is by no means negligible. It would no doubt be still further reduced if the ropes were renewed in good time, as soon as the signs of wear became apparent. In some districts, very good results have been obtained in this way. As the above statements show, one great enemy of wire transmissions is snow and ice formation; this not only impedes the movement of the transmission proper, but also that of the signal, switches, etc., and may prevent the appliance which is being operated from assuming its proper end position.

Most of the administrations therefore justly attach much importance to protective

(1) The weather conditions during the 1908-1909 winter were particularly unfavourable.

casings of the switch gear, and to careful drainage of the ground under the transmitting and the operating gear (24), and no doubt further improvements can still be made in this direction.

In comparing rod and wire transmissions, we also have to consider what necessity there is for any special locking gear on switches operated by the one or the other transmission. We find no great difference in this respect. The managements who prefer rodding in Germany (Alsace-Lorraine and Baden) think it very extensively necessary, in the case of rod transmission, to have separate locking gear in addition to the usual point lock (3). All the switches taken from the facing side, on the Alsace-Lorraine Railway, have such separate locking gear; in Baden, all the switches taken from the facing side by passenger trains, if they are at a greater distance than 300 metres (328 yards) from the cabin and are run over by arriving trains or by trains running through. Rumania, which has also decided in favour of rodding, only uses special locking gear exceptionally, in the case of switches taken from the facing side and situated on curves. On the other hand, Switzerland has special locking gear in the case of switches, operated by rod transmissions, taken from the facing side, on the main line, if they are more than 150 metres (164 yards) from the cabin (this working gear is in connexion with the wire transmissions operating the signals), and also in that of switches which are more than 400 metres (437 yards) from the cabin. The switches taken from the facing side and operated by wire transmissions (10), are protected to about the same extent by the administrations which have adopted wire ropes as their chief means of transmission. In Prussia, all the switches taken from the facing side, which are run over by fast trains, are fitted with control bolts. The only exceptions to this rule are, under certain conditions, switches located near the station platforms. In Austria the same protection is adopted in the case of switches taken from the facing side by passenger trains. On the Russian railways, this is done in a limited number of cases only. This tends to show that the practical experience of many years indicates that there is approximately the same safety, whether rodding or wire is used for operating the switches.

If we also take into consideration that those who are exclusively in favour of rodding for the operation of switches employ almost always wire transmissions for operating the signals, and that the importance of the proper position of the signals is just as great as that of the proper position of the switches, we may conclude with certainty that wire-transmission methods will continually be improved, and switch operation by this method will consequently improve, and existing imperfections will be eliminated more and more. It is true that the question of operating signals by means of rod transmissions has also been considered; but the greater distances involved in these cases makes the matter rather hopeless. As a substitute, the Bruchsal Works have proposed a combination : rod transmissions for operating switches and electric operation of signals. Such a mixed installation is at present in use in Germany on the State Railway at Colmar.

As most of the more important switches operated by rod transmissions have control bolts fitted, this has made it unnecessary to equip them with an electric control of the switch (5) to show if anything is wrong (failure of the transmission, points not home). In Saxony such an electric control was used for a considerable number of years with success, before switches were equipped with the now-usual cuttable switch lock. This control fell into disuse when the newer point locks were introduced.

The use of cuttable locks with separate movement of the points has become very general, and is very generally recommended. But opinions vary as to whether it is better to do the locking (8) by clamping the blade and the stock rail together, as in the hook locks, or by exerting a thrust against the blade from a special point of support, as in the articulated locks. In Germany as a rule, locks with a clamping action are preferred, although there are also many cases where articulated locks with special points of support are used. Russia, Rumania, Denmark, Sweden and Switzerland, pronounce in favour of the system of exerting a thrust against the blade from a special point of support. Austria-Hungary in this respect takes up a special position 6, as here as a rule, Siemens switch bolts are used, which make it impossible to cut open the switch without destroying part of the lock; shearable pins are provided for the purpose. When a switch is cut open in this way, there is no reaction at the cabin; but a locking action comes into play at the bolt, and prevents its movement, after the switch has been cut open. The Breitfeld and Danek cuttable switch lock, which reacts on the cabin, is only used to a limited extent. Except in the case of the Aussig-Teplitz Railway, which uses the Schnabel and Henning device, locks acting when a wire breaks are as a rule not used; it is true that the Austrian administrations draw attention to the fact that the fracture of a wire transmission is very rare, and in some cases has never yet happened; this is probably the result of the nearly exclusive use of chains at the deviation sheaves.

In Germany, Rumania and Russia, favourable results have been obtained with devices for holding the switch in its end position if the wire breaks and for locking the operating lever at the same time (9). One would not like to do without them. Denmark, Sweden and Switzerland have not yet enough experience available to come to a final conclusion on the point.

When the cutting open of a switch breaks the connexion between the operating lever and the swith gear, this has given rise to the fear (7) that it would be possible that a switch (when a route has been made) should be, wrongly, disconnected from the operating lever and then operated with the lever provided for making the connexion. Practice has shown that this need not be taken into consideration. It is generally thought that the only thing necessary is to place the connexion under a lead seal and also to lead-seal the connecting lever. The principle silently observed in the case of many safety appliances here also comes into play, namely, that it is necessary to be protected against the consequences of a mistake, but not to be protected against every possible criminal action of an evil-minded employee.

One special form of wire transmission for switches from which much was expected formerly, was operation with three different positions of the lever (16); in the middle position, the lever releases the switch so that it could be operated locally. This has only been introduced to a very limited extent, except in Sweden. It is only used in a few cases in Baden, on the Moscow-Windau Railway, and on the Swiss Federal Railway, but in Sweden it is used fairly extensively.

Locking of switches.

Questions 12, 14, 15, 13.

Then also the device, from which the wire transmission system of operating switches has developed, the switch bolting (12), is only applied to a very limited extent, except as regards the control locking of distant switches. Only in Denmark are such locking devices frequently used. In Rumania there are none. In other countries, they are used either as provisional safety appliances or in cases where the traffic conditions are particularly simple. The locking devices are as a rule not cuttable (14). Only in Russia are shearable pins used for the locking bars; and on the Stockholm-Rimbo Railway the cutting open of a locked switch disconnects the wire transmission of the cabin.

Arrangements for keeping locked switches in their end position if the wire breaks (15) are stated by some to be desirable; but in most cases they are not considered necessary. There are even important reasons against it, for then if when the wire has broken the switch is locked in the end position, the switch can no longer be operated by hand, after the object of the locking has been attained, and it may be absolutely a necessity, for traffic purposes, to operate the switch. But it is an advantage if the fracture of a wire prevents the operation of the levers in the cabin; and most installations are so arranged.

A matter of importance is the distance up to which switch locking can be considered reliable (13). For it represents, at the same time, the limit of the distance at which switches can be operated, special switch locking being also used. This largest locking-distance is as a rule 500 to 600 metres (547 to 656 yards), with a wire travel of 500 millimetres (1 ft. 7 $^{11}/_{16}$ in). It is true that distances of 800 metres (875 yards) (Swiss Federal Railway) and 1,350 metres (1,475 yards) (Alsace-Lorraine State Railway) are also mentioned, which materially exceed the usual limits of switch operation.

Operation of signals.

Questions 17, 18, 19, 23, 24, 25, 26, 20, 21.

In the case of signalling operations, double-wire transmissions have everywhere replaced single-wire transmissions (17). The latter are no longer used by any of the railways we are dealing with. The distance (18) up to which, on approximately straight sections, double-wire transmissions are considered safe for the proper operation of signals, is stated to be 1,000 to 1,500 metres (1,094 to 1,640 yards), the travel of the wire then being usually 500 millimetres (1 ft. 7 $^{11}/_{16}$ in.) (19). Some administrations however reduce this, according to distance of signal; on the Austrian State Railway it is reduced to 250 millimetres (9 $^{13}/_{16}$ inches).

In the case of signals, just as in that of switches, we have also to note an impor-

tant difference as regards the use of stretchers (23). In Austria and Hungary, stretchers are hardly used at all. In Denmark also, new constructions are made without stretchers. But in the case of the other administrations, the absence of stretchers is the exception, and is as a rule only found when the distance of operation is less than 200 metres (219 yards). The safety action of the stretcher, setting the signal to "danger" when the transmission breaks, must be replaced in the absence of stretchers by a release which if one side of the double-wire transmission becomes slack allows the counterweight of the signal arm to move it into the "danger" position. The advantages of a uniform initial tension and of the strong pull exercised by the gravity stretchers when a wire breaks, are evident. They are however counterbalanced by the disadvantage that the corresponding device has to be inserted in the transmission, and that everything depends on the proper working of this device; not only has it to be protected against the deleterious action of ice and snow (24), but also against illicit interference (22.; for it makes it possible, when the weight is raised (whether direct from the cabin or by pulling the wire), to change the position of the signal without operating the lever.

Then also the system of ensuring that the signal remains in the "danger" position or is moved into the "danger" position by the weight, in the case the wire breaks (25), cannot be considered as wholly unobjectionable, if when a wire breaks a signal already standing at "danger" can temporarily assume the "line clear" position before it once more finally resumes the "danger" position.

A question of particular importance is whether it is advisable to use the signal wire transmission also for opening switch locks (26). That it is not an advantage as regards the operation of the signal, if the wire transmission is a long one, is beyond doubt. Observations have been made showing that the automatic movement of the signal to the "danger" position when a wire breaks can be prevented by such an arrangement; however, generally speaking, no unfavourable results have been obtained with the newer bolting devices, which offer but little resistance. The use of differential locking in the case of intermediate locking has proved very satisfactory, and there are several good designs. Austria-Hungary and Rumania however, do not intercalate such intermediate locking. In Russia it is used very rarely. In other cases, it is not excluded, but it is in cases observed that it is only used to a limited extend.

The same applies to the combinations of the distant-signal transmission with that of the main signal (20), which can affect the efficiency of the wire-breaking safety gear, and under certain conditions even the ordinary operation of the signals. Austria-Hungary and Saxony have therefore adopted it as a principle to have separate transmissions and levers for the distant signals and the main signals, the levers being of course interlocked. The same arrangement exists also to some extent in Russia and Denmark also. But in the other cases distant and main signals are nearly always operated by one lever and by one wire transmission, which is in cases divided at the main signal.

A method of operating main and distant signals, one common wire transmission being used, but developed in quite a different way, has been made possible by the use of electric interlocking (21) in those cases in which the distant signal of a main signal is immediately next to the preceding main signal, or can be erected together with it, for instance when a starting, distant signal is at the entrance signal. It is then not usual to operate both with one wire transmission; but the distant signal is electrically interlocked, so that the circuit can only be closed when the corresponding starting signal is set to " line clear ". This method of operation is also adopted when several signal arms are to be operated by one and the same lever. Otherwise the electric signal interlocking (interlocking of arms, arm flying to " danger " position) is naturally the means adopted for making the train act on the signal and make compulsory the operation of the block system and the signals, thus in the case of starting signals of block sections and other similar cases. The electric interlocking of signals, which at first was only applied with hesitation in the case of hand-operated apparatus, now forms a recognized important and reliable addition to it, and is also beginning to be introduced in the cases in which the mechanical control at greater distances is not by itself considered reliable under all conditions.

Ball and roller bearings.

Question 4.

It is remarkable that ball bearings and roller bearings (4) are as yet but little used on switching gear and more especially on transmissions and distant apparatus, although good results have been obtained with several experimental installations. Only for switch rodding are roller bearings used to any considerable extent. But the fact that in the case of long transmissions it is very desirable that there should be easy operation and action of the automatic safety appliances might form an inducement to pay more attention to ball and roller bearings. It may, therefore, be assumed, that such devices will be used more and more.

Size of frames.

Question 27.

The size of the apparatus which is hand operated (27), is as regards the number of levers, within moderate limits. The greatest size is represented by cabins with 70, 80 or 90 levers; and this no doubt is due to the large amount of space required for such apparatus as well as to the difficulty of operating larger installations.

Improvement of apparatus.

Question 28.

Important improvements in hand-operated apparatus (28) are not in prospect for the moment. However, there is no doubt that further improvements will be made in the combination of electrical and mechanical devices, and it is to be expected that in this way many difficulties, which at present have arisen in the case of purely-mechanical treatment, will be overcome very satisfactorily. Thus the question of safety in the case of the fracture of a wire, is one which is very probably solvable by electrical methods. Then also it may be expected that the development of power-operated installations will stimulate, in more than one direction, the design of hand-operated installations; for at present there is no question of replacing hand operation by power operation in the majority of cases, and attempts will be made to

adapt part of the improvements in power operation also in the case of hand-operated installations.

29-47 : Power operation.

System.

Questions 29, 30.

Power-operated installations (29), within the scope of our report, are nearly entirely limited to electrically-operated and pneumatically-operated installations. On one railway only, in Russia (Weichsel Railway) are there installations operated by liquid under pressure. The most important ones are the electrically-operated installations, the quick development of which is due to the activity of Messrs. Siemens & Halske of Berlin and Vienna, and of Messrs. Jüdel & Co. of Brunswick; in Germany, there are 243 installations, 6,907 switches and 1,824 signals, electrically operated, either in use or being installed; in Austria-Hungary, 22 with 411 switches and 224 signals; in Denmark, 8 with 77 switches and 7 signals; in Russia, 3 with 40 switches and 9 signals. On the Prinz-Heinrich Railway in Luxemburg there are several electricallyoperated installations constructed by the Taylor Signal Company of Buffalo. Taking it altogether, this is already a very important application of electric operation. Among other power-operated installations, there are in Germany 10 electropneumatic installations with 1,135 levers constructed by the firm C. Stahmer of Georgsmarienhütte, and then there are also several administrations in Germany and Russia who have some individual signals operated by compressed carbonic acid, controlled electrically.

Moving of switches.

Questions 31, 33, 34, 35, 37, 36, 32.

The power in the case of electrically-operated installations (30) is nearly always supplied by continuous-current motors, but in Prussia solenoids are also used, in some cases, for signals. In the newer installations, matters are always arranged (31) so that the switch can always be moved, forwards or backwards, whatever its position, and so that after it has been cut open (33), it can be put again into normal condition without anything special having to be done at the switch itself. The electric control of the proper position of the switch (34) is generally such that it checks the correct position of each of the two blades. In some cases however, only the whole operation is checked.

The simultaneous operation of several switches (35) is generally limited to the number "two". As a rule these are related switches; when these are acted on by the one common lever, there is however this difference that the movement of the two switches is not in all cases effected simultaneously, by switching in the motors in parallel, but that in some cases the two motors are arranged so that the one motor first throws over the one switch, and that when this operation is completed, the current is automatically switched on to the other motor, which then begins to throw over the other switch. Prussia prefers the latter arrangement, for if the first switch fails (37), the second remains in its original position. In Austria, good results have been obtained with the two motors connected in parallel. On the whole (36), separate operation of the switches is by far the most general, as this makes

the arrangement of the conductors easy, and also eliminates the disadvantage that if in the case of shunting operations several switches are moved simultaneously, the attention of the operators is as a rule only fixed on one, and that another at the same time can have been moved prematurely. The time required for throwing over an electrically-operated switch (32) is stated to be two and three seconds, and for a pneumatically-operated one, two to eight seconds; the longer periods in the latter case seem to apply to exceptional cases, in which specially-long transmissions were in question. On the average, the time required for pneumatic operation is probably but little longer than for electric operation. The time required when a fluid under pressure is used is stated the three seconds.

Maintenance Failures.

Questions 44, 41, 43, 42.

In order to look after and maintain the power-operated installations (44), specially-equipped mechanics are nearly always considered necessary; if possible they receive the necessary practical training when the installation is constructed.

It is true that up to the present, the number of failures has been rather frequent in the case of power-operated installations (44), although the failures have as a rule not been important. In Germany, where there are already a very considerable number of power-operated installations in existence, there are as a rule more failures than in the case of hand operation. The same observations has been made in Denmark. In Austria-Hungary and on the Russian State Railway, however, power-operation has on the whole shown probably rather more favourable, certainly not less favourable results than hand-operation.

The installations with liquid under pressure, on the Weichsel Railway, receive a less favourable verdict. Not only have there been more failures than in the case of hand operation, but it has also taken more time to remedy them. On the other hand, in the case of electrical operation (43), failures have in nearly all cases taken a shorter time to make good than in the case of hand-operation. The causes of the failures were very varied (42): contacts not properly closed, the loosening of binding screws, faults in the cables, defective motors, the blowing of fuses in consequence of external resistance to the movement, absence of the check of the position of the blade in consequence of the presence of foreign bodies or movement of the track, defects in the insulated rails, etc. At first sight, this seems rather serious, but it must not be overlooked that a considerable number of these failures result from irregularities in the track and the switches, and that these electric installations in this way form an excellent check on the proper condition of the track, wich on the whole cannot be undesirable. The electro-pneumatic installations are perhaps rather less sensitive; Prussia states in this connexion, that the only cause of failures was the leaking of the operating piston.

Advantages.

Questions 40, 38. 39.

A saving in the staff, in the case of power operation (40), is not everywhere effected, but as a rule there may probably be a saving of 20 to 33 per cent, as Alsace-Lorraine, Wurtemberg, Hungary and the Russian State Railway recognize.

Prussia states that it depends on local conditions, whether and what saving in the staff can be effected.

Accordingly opinions also differ, as to what economical advantages there are (38). These are also affected by the occasionally high cost of maintenance, and by the interest charges of the considerable outlay required; the general experience up to date does not show that these are so marked as to form a strong argument in favourof the future extension of power operation. In Austria-Hungary however, economic advantages have resulted both as regards staff and as regards maintenance.

The question of the economic advantages is however in this case also not the only deciding one; the most important point at places with much traffic is to have such arrangements that the staff can, without being overworked, work the service smoothly, quickly and safely (39). All the administrations which have up to the present used power installations agree that they make it easier to work the service; this is a sufficiently-great advantage to make it certain that power installations will be used in future, in spite of sundry existing minor defects. Therefore those administrations also, who have already tried power installations in cases of much traffic, consider the further extension of power operation in the case of installations at large stations (47), particularly as there is no doubt that progress will be made and such devices will become more and more reliable. Electric operation by motors in such cases receives much more attention than other systems. The administration of the Prussian State Railway, which alone has a considerable number of experimental electro-pneumatic installations in use, states that the comparative trials are not yet completed.

Future applications. Question 47.

Any suggestions for the improvement of power installations (46) are not made, except as regards some minor constructive details; this is very natural, for the administrations are at present engaged in testing and adapting the existing appliances, which are the result of the excellent and ingenious work of inventors. It must however be mentioned that a certain difficulty arises from the fact that the electrical installations require continuous current, while single or polyphase currents are available at so many places. The desire expressed by Saxony, that it should also be possible to use alternating-current motors, therefore does not seem unjustified.

Improvements. Question 46.

Now although there seem to be fundamental differences between installations operated by hand and by power, keeping them quite distinct, there are nevertheless signs that intermediate forms may become evolved. When carbonic acid is used, it is already possible to carry out certain operations in connexion with hand-operated installations as power operations, by using compressed gas and an electric control. The more recent installations of this kind (45) for individual signals which are a long way off, have given good results. Just as well is it possible, where suitable current is available, to carry out individual operations by electric

Individual power appliances. Mixed operation. Question 45.

power and so to relieve mechanically-operated installations in cases where it may be necessary to operate at greater distances than they can be depended on. As stated above, this has already been done on a large scale; at Colmar (Alsace) there is a cabin equipped for the electric operation of signals, with a rod transmission for the switches; this a given satisfactory results for several years now, and appears to act as stimulus to other similar applications.

If to make the work of the signalman easier is the only question involved, the arrangement might be considered of equipping installations operating signals at a distance with power-driven gear, to be set in motion as required, the actual work of operation being done by a small motor. Trials of this kind were formerly made by the Saxon State Railway, but did not lead to any result.

48-65 : Signals and switches generally.

Signals.

Questions 48, 49, 51, 50, 52, 53, 54.

Among the devices which are found both in the case of hand operation and in that of power operation, we may in the first place mention those for ensuring that the signal is in its proper position. The electric checking of the " line clear " and " danger " positions (48 and 49) is applied in the case of all power installations, but in that of hand installations only to a very varying extent. Only some the administrations consider these checking devices indispensable for whole classes of signals, especially entrance signals. Among them are the Alsace-Lorraine State Railway, the Hungarian State Railway, the Austrian North Western and South Northern, and the Swiss railways. In other cases, the degree of visibility of the signals, the length of the wire transmission, and any existing interlocking of the signal levers with any other appliance are the deciding factors, whether an electric check of the position of the signal is to be considered necessary or not. The check as a rule only exists in the case of main signals, and that for both the positions " line clear " and " danger ". The Swiss Federal Railway is of late also checking the intermediate position; in which the meaning of the signal is doubtful. On the other hand, some of the railways only check the " danger " position, as this is the most important from the point of view of safety, and that in such a way that in case the check does not show the signal at " danger " the corresponding part of the line has to be considered unprotected. The check is not as a rule applied to caution or slowing signals or their positions. Moreover, except in the cases of signals operated by power installations, the signal-control current is not utilized for locking or unlocking parts of the mechanism (51). But it seems worth while, taking into consideration the possibilities of failure which exist in the case of long wire transmissions, particularly if they include some locking gear or also have to operate several signals, to consider whether the electric control of signals should not be adopted generally, and whether the absence of the indication that the signal is standing at " danger " should not have the same locking action at the cabin as if the signal lever had not been thrown over. It seems also advisable to extend this

electric control of the signal to the distant signals, which in practice are at least as important as the main sigals.

An electric check to show that the signal lanterns are alight (50) is generally dispensed with; it also does not appear to be taken into consideration for the future, to judge from the results obtained. Only in cases where electric signal lights are used (tunnel signals in Switzerland; a few signal lights on the Russian State Railway and a switch section signal in Saxony), is a check provided by a control lamp in the same circuit.

The ordinary illuminating power of the signal lanterns as a rule appears to suffice (52 and 53). Attempts to improve the illuminating power have only been made in Baden (by increasing the size of the reflectors), in Saxony (by unsymmetrical arrangement of the reflectors for the front and back light), and on the St. Gothard Railway (by increasing the size of the burners). Electric lighting has been applied to a number of signals with considerable success. Trials of acetylene lighting did not give satisfactory results.

In some districts, liable to fog, the effect of the signals is reinforced by repeating the lights at definite intervals. A yellow double light has been introduced in Germany since 1901 on several large experimental sections (extending altogether to over 200 kilometres [124 miles]), as a "caution" distant signal; this light shows up much better than the other coloured lights because the amber-yellow glass absorbs very little light. It will probably be introduced in the whole of Germany for distant signals. The yellow distant signals are also used in Denmark.

All administrations are striving to prevent the fracture of the signal-light glasses (54). The chief measures adopted are wire glass, as well as an elastic setting or one which gives a little, such as tin, leather, lead, etc. It is also important to reduce any shock resulting from the impact of the mass of the signal; counterweights and spring stops are used for the purpose. Some administrations consider wire glass very useful; in other cases (Swiss Federal Railway), it is considered unsatisfactory. It is true that it cannot readily break into pieces, but it easily becomes cracked and crumbles, so that part of the white light passes through.

Switches.

Questions 55, 56, 57.

The possibility of the hand-operation of switches on the spot, in cases of failure (55), is everywhere provided for; in the case of electric motors frequently only by the provision of an auxiliary cranked handle; in this case, the operation takes a comparatively-long time. In the case of hand and power operation, the lever which is there ready, is fitted into the gear and connected with the switch without difficulty. On the Saxon State Railway, the hand levers are left permanently in place, and as a rule they are only kept disconnected.

Particular conditions exist in districts where spring switches are used (56); the blades of these switches can only be moved into the other position by overcoming their elastic force, which is not inconsiderable. This elastic force amounts to about 50 kilograms (110 lb.), and acts at the blade not in contact in the direction

opposed to the movement produced when the switch is cut open. Thus theoretically it is to some extent in contradiction with the cuttableness of the switch. As, however, this force of 50 kilograms (110 lb.) only comes into play to a materially smaller extent and as on the other hand the forcing open of the lever interlocking in the cabin, when the switch is cut open, requires a force of about 200 kilograms (440 lb.) acting on the transmitting parts, there remains in the case of spring switches an ample margin of resistance against the cutting open. Nevertheless, provision is made in the case of electric operation (57) to increase the resistance to movement of the blades in their final position by adding a spring friction catch, so that from this point of view there is nothing against extending the use of spring switches. In the case of compressed-air operation, no particular devices at spring switches are necessary, as the pressure behind the piston overcomes the resistance of the blade readily. Up till now, within the limits of the countries we are considering, it is only in Germany and Austria-Hungary that spring switches set from a distance are used, in most cases experimentally. It is, however, to be expected that their use will become extended, as they present advantages not only from the point of view of smooth running, but also from that of maintenance, and prevent any longitudinal movement of the blade relatively to the stock rail; and this is particularly desirable when points with the blade and stock rail clamped together ase used.

Inclusion of barriers and gates.

Question 58.

Besides signals and switches, barriers and level-crossing gates are also frequently operated from the cabins (59). Both can be included in the route interlocking, so that the corresponding signal cannot be set to " line clear " until they are in the proper position for that purpose. But nearly everywhere, only the barriers have been included, while the level-crossing gates are only operated from the cabin, but not interlocked with the route mechanism, in order not to stop the street traffic the whole time the block continues. This relief to the street traffic, however, results in increased responsibility for the signalman. The uniform practice of the majority of the administrations shows that this is, however, considered the lesser disadvantage.

Action of trains on cabin.

Question 62.

A material improvement in the value of the safety appliances has been effected by making the train co-operate (62). This makes it possible, by the use of treadles and rail contacts, to make any operations in the cabin dependent on the condition that the train has passed a given spot or has left a given section of road. This is effected by having electric block fields in the signal bex, or by electric interlocking with the signals, unlocked by the train; the latter is more particularly the case at the beginning of block sections. Devices of this sort have been very largely introduced not only in the case of power operation, but also that of hand operation.

It is true that rail contacts are also used to notify the approach of a train, but only in a few solitary cases.

One of the most important questions in railway working has always been, how

cases of the over-running of signals can be prevented, reduced or made harmless. Distant signals and detonators give valuable results in this connexion, but they cannot absolutely prevent the men on the locomotive from overrunning a signal if there is thick weather, if the signal light has become extinguished, or if any occurence strongly attracts their attention. Detonators, if powerful, are bound to be noticed by the driver even under unfavourable conditions; as a rule, they are used only in cases of fog or if a section has unexpectedly to be blocked, and thus in many cases the possibility of the danger mentioned continues to exist. Consequently in some cases, alarms or gongs have been added in the distant signals; these continue to sound, when the train passes, if the signal is set at " danger ". But it has also been considered desirable to have some means of drawing attention to the spot where the distant signal is located, without putting an extra load on its wire transmission by a second device which has to be operated. Among such are, besides the strengthening of the illuminating power of the signals lights and having several lights, as already mentioned, also the large marks at the distant signals, made of sleepers and used in Prussia, and the sound-reflecting walls, now being tried, which are to attract the attention of the locomotive driver by reflecting the noise made by the trains, as in passing under bridges. Electric and pneumatic horns which are automatically started by the trains, have also been tried at distant signals for the same purpose. These devices have not, however, been introduced to any large extent, and have mostly not passed the stage of long experimental trials, except in the case of the large marks at the distant signals, which are very satisfactory in a limited way, but cannot be considered to be a very powerfully-acting accessory.

Prevention of over-running of signals.

Question 59.

Then also many inventors have for tens of years aimed at making a warning signal appear or sound in the locomotive cab (59) when the train approaches a main signal standing at " danger ". But only few of the devices proposed have proved at all promising. In the countries we are considering, matters in this respect have as yet only reached the experimental stage. The chief difficulty is that the electric-contact devices for conducting the current from the line to the locomotive (such as the Lartigue " crocodile " contacts) cannot be depended on to act satisfactorily under unfavourable climatic conditions, as extended trials made by the Saxon State Railway on a line in the Erzgebirge have shown; and that mechanical devices are not only very liable to destruction in consequence of the high speed of trains, but also exercise a bad influence on the reliable working of the distant signal, if connected with it. Nevertheless, several experiments have recently been begun in Germany with the van Braam signalling system, in which a treadle on the line acting on a sensitive lever with a transmission to the cab, fitted to the locomotive, operates a powerful signal, records the operation and if required also applies the continuous brakes. The latter seems at first sight a desirable action from the point of view of safety; but weighty objections have been raised against it.

Attempts are also made to obtain a certain amount of protection against the over-running of signals by having every case of over-running, even if it has not been

attended by any detrimental consequences, recorded by an automatic recording gear; and afterwards the driver is afterwards held responsible. This is effected on different stations in Prussia by a recording counter fixed in the office of the traffic manager, which is operated by means of a rail contact each time a signal is over-run. At the same time an alarm is released, which draws attention to each individual instance, so that these can then be properly recorded in a book.

Catching of trains.

Question 61.

The extreme measure to meet danger from the over-running of signals (61) is to turn the train into a side track, on which the train can run itself out or is stopped by sand (Köpcke's sand tracks); this is adopted by several administrations, in suitable places. On the other hand, on dead-ended tracks where only a small distance is available for the braking, sand is placed with hydraulic buffer stops at the end, in order to stop a train should it have come in too quickly. As a result of extended experiment, Saxony is lately considering the use of skids, which oppose to the pushing action of a train a considerable frictional resistance, reinforced by springs, designed for a length of stop of about 30 metres (33 yards).

Audible signal for trains which must stop at the entrance signal.

Question 60.

A special system of signalling has in a few cases become developed at advanced entrance signals, at which trains have sometimes to wait a long time. The German regulations specify that in this case the locomotive driver should receive the order "wait" (60). If this order cannot be given by an employee by means of a horn signal, an electric trumpet or syren is successfully used; this is placed near the entrance signal and operated from the station and signals "wait" by the Morse code, a series of short and long sounds being given.

Co-operation of traffic manager in setting to "line clear".

Question 63.

The setting of a signal to "line clear" is nearly generally made dependent on the co-operation of the traffic manager (63), by means of electric, or more rarely of mechanical unblocking devices, or by means of contacts which have to be made before the signal can be operated.

Indicators for shunting services.

Question 64.

Very good results have been given, in the case of a shunting service, in order to communicate between the top of the inclines and the switches at the corresponding sorting sidings (64), by loud-speaking telephones as well as by electric track indicators, which are constructed on the pattern of needle telegraphs. Track indicators which have incandescent lamps lighting up behind transparent number plates have also been used with advantage.

Mechanical needle instruments with a wire transmission have also been used instead of the electrical instruments. In many cases however, for instance in Switzerland, the siding numbers are only written on the buffers of the descending wagons; in Bavaria, numbered plates are hung on the buffers.

Newer installations and arrangements are devised with the object of making it unnecessary to given individual indications in the case of each descending wagon as

in accordance with American practice the order of sequence of the different sidings on to which the wagons are to run is laid down in advance in writing, so that the switches can be set in succession in accordance with this list. A further step in advance is the use of power installations to carry out the sorting operations required; in the system devised by Messrs. Siemens & Halske a paper band, perforated to correspond to the list, regulates the sorting automatically.

Any further improvements in connexion with switching and signalling appliances (65) are not contemplated by the different administrations. *Improvements* Question 65

In connexion with this discussion of switching and signalling appliances, we would mention a system intended, where traffic conditions are simple and where expenditure is to be avoided, to serve to some extent as a substitute for the necessary mechanical or electrical relation between the position of the signals, the position of the switches and the running of the trains. *Phono-indicator.*

The Russian Polessia State Railway has installed at seven of its stations an electric system for the control of the signals and switches, devised by its telegraph superintendent Oberst von Fiedler and called "Phono-Indicator". This enables the official controlling the traffic to send orders to the switchmen and the signalman to set the switches and the signals for a train, and also to see at any given moment in what position the switches and signals are.

While the switch is being operated, a trembling bell continues to sound until the switch blade is right home. A similar bell at once attracts the attention of the man in charge if by mistake he sets an entrance signal to "line clear" when the corresponding switches are in a wrong position.

This warning signal also sounds if two incompatible signal operations care carried out simultaneously.

The chief constituent part of the arrangement is an accurately-working switch contact, not affected by the weather. Any faults in the circuit are automatically announced by the bell. In addition to the electric ordering and controlling apparatus there is also telephonic communication between the station official and the switchman.

An extended controlling system, the centralized phono-indicator, has been developed for stations with more than three tracks; this is designed so as to satisfy all the requirements of a good centralized installation, with the sole exception of the interdependence produced by interlocking.

It is quite intelligible that with such a centralized system of control the safety conditions at a station where the switches and signals are operated singly by hand can be materially improved. The inventor himself however by no means proposes this as a full substitute for interlocking installations, but recognizes that these, if dependent also on the official managing the traffic, give the best security against the making of any mistakes.

66-77 : Electric interlocking of route levers.

Mechanical and electrical interlocking.

Questions 66, 67.

The interlocking of route levers (66) is nearly always effected electrically.

Wurtemberg and Switzerland however only use electrical interlocking rarely and chiefly apply mechanical interlocking. In Bavaria also this interlocking is applied in the case of station blocks. The Ssysran-Wjasma Railway has only mechanical route lever interlocking.

In the cases where route levers set to " line clear " are interlocked, the route is often also set by mechanical locking, without any intervention of the electric current in the first place, while an electric current is used for clearing. Continuous-current solenoids are generally used for locking.

Rumania and Denmark use this interlocking exclusively, with mechanic allocking and electric clearing.

Interlocking is everywhere recognized necessary in the case of entrance-route levers.

But departure-route levers are to a great extent interlocked in the same way (67). The existing exceptions are to be found where sections without block apparatus begin.

Interlocking by signalman. Automatic interlocking.

Question 68.

The system very generally adopted is that the interlocking of a route is effected by the signalman by a separate operation (68), an electric current being used; this system owes its adoption to the extensive use of the Siemens & Halske block apparatus. On the other hand, automatic locking when the lever is thrown over is also used in many cases. It has given satisfactory results not only in the case of power-operation, but has also been favourably mentioned in connexion with hand-operation.

In all cases where it is necessary to make certain that the switch is not movable while the train passes and the signalman has consequently to lock the route lever in the position corresponding to " line clear ", the mechanical or electric interdependence of the route locking and the signal compel the signalman to carry out this operation (69), before it is possible to set the corresponding signal to " line clear ". In the case of locking the route lever in the final position (position interlocked with the signal) this compulsion generally depends on the interdependence with the official managing the traffic.

Compulsion to lock.

Question 69.

In the group blocking adopted in Saxony the route levers are not interlocked in the normal position; consequently, there is no compulsion for any operation of this kind. But, on the other hand, the signal levers are locked in the " danger " position by the previous blocking operation, and before release the connexions for the route and consequently also the necessary switch movements cannot be made. Consequently the signalman has to close his sections by blocking his signal if he wants to move his switches for shunting operations or in order to make a new route. Thus this blocking replaces the otherwise very usual locking of the route levers in their normal positions, and at the same time when the section is closed, it forms a

necessary condition for the dispatch of unlocking, without which no other train can approach.

In Prussia, in the case of installations where there is section blocking after a train has entered, the signal lever has in the first place to be locked in the " danger " position. This is effected by a double key simultaneously with the blocking of the end field, by which the section behind is open. This blocking of the end field is however only temporary and again cancelled when the route lever brought back into the normal position and then locking the signal, is locked by the blocking. The latter operation, which at the same time releases the unlocking field of the official in charge of the traffic, is thus absolutery compulsory, as until it has been carried out the official cannot give permission for another train to enter, nor can the signal be set to " line clear ". Such a compulsion does not exist in Prussia in the case of departure tracks.

In the cases of departures the compulsion for the locking of the route levers in their normal position, and for the simultaneous closing and protection of the section against other departures is more and more effected by the electric interlocking of the signals (for making the signals fly to " danger ") which when the train passes over rail contacts makes the signal fly automatically to " danger " and naturally only makes it possible to set it to " line clear " after the signal lever has been moved back into the " danger " position.

But when the signal lever has been moved into this " danger " position, it is locked in a simple way by a signal lever bolt connected with a locking bar, and this is only released when the signal lever or route lever locking has been completed; so that another train can only be admitted when the different interdependent block operations have been carried out in the proper order.

In principle, there is naturally no objection to the application of such signal coupling devices to entrance or block signals. Up to the present, however, this application has as a rule been limited to cases in which sufficient safety was not obtainable by any other method.

Locking by continuous or alternating current.

Question 70.

As regard the locking gear (70) for hand-operated installations, alternating current is as a rule preferred. Continuous-current interlocking is used, exclusively in Wurtemberg, chiefly in Denmark, and in some cases by other administrations when the locked route is to be cleared by the trains.

In the case of power installations, continuous current is chiefly used.

Route locking during the journey.

Questions 71, 72.

The possibility afforded by the electric route interlocking to prevent with certainty any movement of the switches while the train is passing, and that independently of the switchman, is recognized by nearly all the administrations as of much importance from the point of view of safety, and utilized; the locking (71) being effected in the " line clear " position, and the release either by the train itself or from a spot at which it is possible to ascertain that the passage of the train has been completed.

The method and means of release (72) depend on the nature of the locking

appliances used (continuous-current or alternating-current installations); it is effected either by means of a special alternating-current unlocking field at the station itself, in which case the official in charge has to attend to the apparatus, or is made dependent on his co-operation, or is effected by the train itself, which unlocks the locking when passing over a rail contact.

Group interlocking. Route contacts.

Questions 73, 74.

The answers of the different managements on the subject of interlocking several route levers by one common applianee (73) show that such appliances are largely adopted, but that there are also very great differences in the construction and action of such appliances.

The most usual arrangement is that every route is it is true locked in the normal position (" route closed ") by a separate locking gear, but that for locking in the " line clear " position there is only one common locking gear for each group of routes which mutually exclude each other. Consequently for unlocking this only one unlocking field is necessary, which has to be operated after the train has passed, while for releasing the route levers when in their normal position there are as a rule as many unlocking fields, as there are routes to be considered.

In Bavaria, the arrangement is simplified in so far that the incompatible routes can be released by the official controlling the traffic by a blocking field or the main block, after the circuit has been made by special contacts, and the route locking effected for the passing of a train can be cleared by means of a second blocking field. The number of positions of the contacts corresponds to the number of route making fields in the installation. Similar arrangements are also to be found in Baden.

In the case of the group blocking introduced since 1886 in Saxony and mentioned under (69), there is one common locking gear (generally consisting of two parts) at the apparatus, both for releasing as well as locking during the passage of a train, for incompatible routes; the one part locking in its normal position the signal, the other part intended to keep the routes locked while the train passes.

The current required for releasing a signal only passes to the signal-blocking field, if on the one hand the official managing the traffic connects the conductor for the route in question by means of a special key (consenting contact) with the source of current (station blocking with magneto), and on the other the correct route lever is thrown over in the signal cabin and locked, the corresponding conductor being then automatically connected with the signal blocking field.

The unlocking of the route locking after the train has passed cannot be effected until the signals have been locked electrically at " danger " and requires either the co-operation of the official managing the traffic, at the corresponding contact, or that of the train by means of a rail contact.

The Rank system, which is much used in Austria, is nearly related to the Saxon group locking with consenting contacts. In this system, sliding contacts are used instead of the consenting contacts operated with a key; these contacts are moved on a slide plate arranged like a plan of the tracks, so that the position of the contact at the same time shows clearly that the track in question is occupied.

In the case of single-track railways the use, of such group blocking makes it possible to treat the entrances and departures on one side of the station as a group, as they are incompatible; and very simple block arrangements result.

The use of group blocking involves the connexion of the route lever bars with contacts (74), which, as already stated, only make the circuit for the releasing current when the bars have made the proper routes. But sometimes contacts are also placed on the route bars in order to make circuits for the electric interlocking of signal arms and releasing block keys and route locks.

At present but little need has been felt that the electric interlocking of signals or switches should be effected without the action of the route lever (75). Such appliances are used in a few cases, for instance in very simple installations. Prussia however intends to apply such a system in the case of power installations.

Interlocking without action of route lever.

Question 75.

In the cases in which sufficient experience is available, the electrical route-interlocking has without exception given favourable results (76). There is no expression of opinion in its disfavour even in cases of much traffic. Several administrations also speak in favour of mechanical route-interlocking. It is however to be noted that Prussia does not intend to use mechanical interlocking in future. Electrical route-interlocking is also strongly recommended in the case of new installations (77); in some cases, attention is also drawn to the fact that under circumstances mechanical interlocking may also be advisable.

Reliability.

Questions 76, 77.

78-94 : Measures to prevent the premature operation of switches.

As a rule pressure or contact treadles are used in order to prevent the operation of the switches taken from the facing side, before the whole of the train has passed (78). The Austrian North Western and the South Northern have however been giving up the use of pressure and contact treadles for this purpose, and prefer switch control locks together with mechanical and electrical route-interlocking. Bavaria has since 1896 been replacing them by electrical appliances.

Keeping switch fixed while the train passes.

Question 78.

In Alsace-Lorraine pressure and contact treadles are used at switches also when taken from the trailing side.

Time locks, which lock the switch for a certain time (79), are as a rule not much used for the purpose mentioned under 78. Experiments made in Saxony and Baden with these appliances have not given favourable results. Owing the technical and practical difficulties they are no longer used in these countries.

Time locks.

Question 79.

Only in a few instances, but in a number of different shapes, are mechanical devices, such as pressure or contact treadles, used in combination with the electrical appliances (80). Alsace-Lorraine for instance has pressure treadle levers in the continuous-current block apparatus; Saxony has canting rails with electric contacts and Wurtemberg lever locks in combination with insulated rails. In Austria-Hungary and in Switzerland, pressure or contact rails are used together with insulated rails and lever locks, in order to make the operation of a switch impos-

Pressure and contact treadles.

Questions 80, 81, 82, 83.

sible before the whole train has passed. The Austrian Southern also uses the so-called contact treadles. Two of these, each 7 metres (23 feet) long, are placed behind each other, or next the two rails so as to overlap a little. The electric release of a continuous-current lock, making it possible to operate the signal and unlock the route locking, is only made possible after both treadles have been pressed down simultaneously and have once more resumed their former level.

The proper length of the treadles (81) is generally given as 10 to 12 metres (32 ft. 10 in. to 39 ft. 4 in.). In Saxony there are some 13·5 metres (44 ft. 3 $^1/_2$ in.) long, and in Wurtemberg 15 metres (49 ft. 3 in.). The important factor in the settlement of this question is naturally the greatest distance between wheels in regular use.

All the lengths mentioned above have proved satisfactory from the point of view of construction (82). Some administrations however state that they are not yet able to give a definite opinion on the point.

Pressure and contact treadles have as yet only been used on curves (83) by a few German and Austrian administrations, and also in Rumania, and that with good results. According to Prussian experience, the smallest radius admissible is 180 metres (9 chains). It is observed that these require more careful maintenance, as they are very liable to jam if there is any creeping. Rumania remarks that good results with contact treadles are only obtained at curves if they placed next the superelevated rail.

In addition to the mechanical appliances mentioned for locking the switch in position till the whole of the train has passed, all the administrations we are considering also extensively use perely-electrical devices (84).

Locking by electrical devices. Insulated rails. Rail contacts.

The most usual of these is the electrical block apparatus for locking the route levers in the normal or in the " line clear " position.

Questions 84, 85, 86, 87, 88, 89, 90.

Insulated rails placed before the switch are used for the purpose; while the train is passing over them the switch lever is locked.

Bavaria attains this object in the case of hand-operated installations by fitting a special bolt to each of the corresponding switch levers; this bolt can be operated electrically from the signal box by turning an indicator handle if the insulated rail before the switch is unoccupied. If it is occupied and the signalman should turn the handle, the current would be short-circuited and pass to earth through the axle on the insulated rail and would not reach the bolt. The signalman is informed that a train is passing over the insulated rail or is standing on it by the sounding of an electric bell in the signal cabin. In addition there is an indicator in the form of a small red or white disk showing whether the switch lever is free or is locked.

This arrangement is more recently also used for clearing the routes; with this object in view it is also equipped with a mechanically-acting wheel detector.

In order to arrange matters so that the action (85) of the purely-electrical devices does not terminate before the last axle has passed, insulated rails (86) have been used with good results; instead of them contact treadles can also be used. In other cases the necessary safety against premature operation is obtained by placing the

rail contacts at more than a train length from the spot which the whole train has to pass, before it is possible to operate the electric contact gear.

That insulated rails (87) can be used not only for preventing the premature operation of switches and other block apparatus, but can also have important applications for releasing electric arm interlocking, is evident from what has been stated under (62), as insulated rails belong to the class of rail contacts and can be used like them, so as to protect a departing train by making it automatically close the section.

Wurtemberg also uses insulated rails for controlling the departure of trains, the Austrian Southern Railway also for closing an entrance section until the train which has previously entered has departed, also for announcing arrivals and for operating bells when a train approaches.

Switzerland has as yet not used any insulated rails.

The fishing of insulated rails (88) is nearly always effected by wooden fishplates (made of hornbeam or of Australian hardwood), which have given good results. In Saxony, the action of the wooden fishplates is reinforced by the addition of a short longitudinal sleeper made of oak and supported on iron transverse sleepers; this not only adds to the stiffness of the rail at the insulated joint, but also materially helps to prevent any movement of the rail ends relatively to each other.

On the Austrian Southern Railway, good results have also been attained by wooden framing placed under the joint.

When rail contacts are used, the circuits are as a rule made (89) as follows: when the train passes on to the rail this is bent and closes a mercury circuit. Experiments have been made recently with the so-called drop contacts of Messrs. Siemens & Halske, in combination with electric block key bolts for intermittent continuous current, and good results have been obtained. As compared with the usual arrangement, this appliance has the advantage that after the rail has once been bent, a number of current impulses are required for interlocking; these are obtained in a very simple manner by the mercury drop contact by the intermittent outflow of the mercury forming the contact. The use of these appliances will be particularly advantageous in the cases where there would otherwise be a possibility of interlocking produced by the action of atmospheric electricity or of stray currents. The co-operation of the train in the safety measures, which results from the use of simple rail contacts, is no doubt a very valuable but not quite perfect method; but there is no doubt that it is much improved from the point of view of safety by the automatic production of intermittent current.

As the above shows, insulated rails and rail contacts (90) are principally used for locking and unlocking levers and other block apparatus in the cabin; sometimes they are also used, as in Wurtemberg, Denmark and Russia, for warning the signalman. Other similar applications are also made in individual cases.

It seems more especially very natural that such appliances should be used in order to announce automatically the approach of a train at a level crossing where

there is a fair amount of traffic, so that the gates may only be closed a short time before the train arrives. It is also desirable that a train should automatically give notice of its approach, so that any necessary precautions may be taken, at level crossings without gate keepers on secondary lines; also at places where the line leaves a tunnel, or goes over and iron bridge, and a busy street is alongside, where horses may easily be terrified by the sudden appearance or the noise of the train. But all these methods of announcement have unfortunately the disadvantage, that their failure does not notify itself and may consequently give rise to misunderstandings resulting in serious accidents. The advantage obtained in the one way is counterbalanced by the serious extra responsibility resting on the maintenance staff. It is accordingly intelligible that there is a certain hesitation in adopting such methods.

Other locking devices.
Question 91.

As regards the prevention of the premature operation of switches, besides rail contacts, insulated rails and treadles, there are also some simple mechanical devices in use (compare 78 . Thus the Austrian North Western and the South Northern use switch control levers for this purpose, depending on the mechanical and electrical route interlocking gear (91); such control locks with portable keys have also given very good results in many other cases for obtaining relations in simple switch and signal installations and for combinations of switches and switch blocks.

The electrical devices used in Bavaria instead of pressure and contact treadles, especially the much-used lever locks, have already been referred to under 78 and 84.

Field of application.
Question 92.

It is a nearly-generally accepted opinion, that it is desirable that all switches taken from the facing side should be fitted with devices to prevent the premature operation of the switch (92). There are only a few administrations who consider that it is sufficient if such devices are limited to those cases, in which the switch cannot be properly seen from the cabin and has to be operated immediately after the train has passed.

There is but little need to extend the use of these devices to switches which are taken from the trailing side. This as a rule only has to be considered in the case of switches which are at a great distance or cannot be seen from the cabin and are much used for shunting operations.

Reliability.
Questions 93, 94.

No particular difficulties in the service or in maintenance (93) have arisen from the use of these safety appliances for preventing the premature operation of switches. The general opinion on the contrary is that they have a favourable influence on the carrying out of the service.

An unfavourable opinion is however expressed in several cases as regards time locks (compare 79). The St. Gothard Railway does not consider them suitable for stations at which much shunting work takes place. In Rumania also they did not in all cases give favourable results. It has already been mentioned that in Saxony and Baden technical and maintenance difficulties arose in connexion with the time locks, and therefore their use was given up.

Nevertheless they are a simple and valuable auxiliary for the locking of solitary switches; several administrations will in the future 94 use them as well as pressure and contact treadles and insulated rails. When several switches however have to be locked for one given train, the preference is as a rule given to electric route-interlocking.

Alsace-Lorraine prefers the insulated rail with added rail contact connected with a continuous-current blocking field on the locking of a block key. The Austrian Southern considers that the best to use at large stations with block system are electro-mechanical treadle rails; at smaller stations, pressure treadles; and at switches not otherwise protected, Schilhan treadle rails.

Denmark, Sweden and Switzerland do not speak in favour of any definite system, partly because enough experience is not yet available.

95-103 : Graphic representation of the occupation of platform tracke.

Graphic representations with fixed indicators.

Questions 95, 96.

In order to facilitate the management of traffic at very busy stations, some of the Prussian administrations use graphic representations (95), in which the occupation of the tracks is marked in advance (96) in accordance with the time-tables.

The traffic and maintenance offices in Saxony use such representations in the form of plans showing the operation of the traffic only in order to be able to judge the effect of proposed alterations in the operation of the traffic or in the arrangement of the tracks. Such representations are not used in Bavaria, Baden and on the Swiss Federal Railway, but on the other hand there are appliances provided (block relations, order of route levers) at the chief apparatus or at the cabin which, when a train is there, close the entrance to the track in question until that train has taken its departure and the occupied or unoccupied condition of the track is notified in the cabin by coloured disks.

Movable indicators.

Questions 97, 98, 99, 100.

Wurtemberg, in order to show the occupation of the tracks, only uses indicating plates.

In cases of the latter kind the occupation marks are movable, while in the former they are not (97). A simple method of graphically representing the occupation of the tracks by means of movable marks is as a rule available in the case where the separate lines or routes are made by the official managing the traffic by operating blocking fields or contact devices, in which the locked or unlocked condition of each separate route is indicated by coloured disks appearing behind small windows in the signalling apparatus.

These signal windows are as a rule arranged in the same order as the corresponding rails, so that the state of occupation is easily grasped. This system of graphical representation is particularly developed in the Rank block apparatus which has already been mentioned (compare 73) in which the releasing contacts are closed by buttons, which can be moved along the lines on a diagrammatic plan of the station, which represent the tracks.

In the case of the appliances commonly used in Bavaria and Baden and on the Swiss Federal Railway the change of the coloured disks, showing the occupation of the tracks, is effected when the route lever at the station or signal cabin is operated.

Any system of effecting the movement of the marks indicating the occupation of the tracks from the outside (98), such as automatic adjustment produced by the movement of the train on the tracks in question, does not seem to be in use anywhere; but on the other hand the setting of the marks often has a restraining or permissive effect on the signal apparatus (99).

We may also include here the automatic electric device of Messrs. Siemens & Halske (compare 64), in which the succession of the shunting operations is marked on a strip of paper by means of punched holes, and is then automatically carried out by the apparatus.

Other relations between the graphic representations and the train movements and the occupation of the track concerned (100) have as yet not been effected.

Field of application of graphic representations.

Questions 101, 102, 103.

The graphic representations of the occupation of the track, mentioned above, are by no means limited to platform tracks; they are also frequently extended (102), in so far as they are used at all, to other entrance and departure tracks. This applies especially if we also include among them the marks appearing in the case of electric unlocking appliances. With this extended meaning attached, it also applies in some cases to locomotives running light, while graphic representations proper, of the occupation of the track (101), are not used in these cases and in the case of shunting operations.

The arrangements mentioned are stated to give good results both as regards the facilitation of the service and as regards safety (103). The use of graphic representations has proved especially valuable when special trains have to be intercalated.

In organizing the train service at a large station, as far as the point of view of safety is concerned, the importance of such graphic representations is small as compared with the further development of electrical checking devices and means of communication, which make it possible for the different apparatus to work separately and yet form one united whole from the point of view of safety.

CONCLUSIONS.

The chief conclusions to be drawn from the answers and information concerning question X received, are as follows :

Hand-operation.

1° The newer developments in the methods of operating switches from a distance have extended more especially in the direction of double-wire transmissions, and

have resulted in appliances giving results which are satisfactory from the point of view of safety, although still capable of improvement; there is therefore no reason from departing from this direction;

2° The operation of switches by means of rod transmissions is preferred to a smaller extent, in some cases only under special local conditions; such transmissions are less liable to fracture, but any fracture is not controlled automatically as easily as in the case of double-wire transmissions;

3° The operation of switches at a distance should also be combined with locking (switch bolts, blade locking, or should be made safe by separate subsequent locking (control locking);

4° In the case of important switches taken from the facing side, whether the transmission be by rod or by double wire, it is in many cases considered necessary to have control locking in addition to the locking of the cabin apparatus;

5° The use of reacting cuttable switch locks with separate operation of the switch blades has given good results. The most usual way of securing the blade is by a thrust obtained from a special point of support, but switch locks in which the blade and stock rail are clamped together are now used more extensively;

6° Switching gear with wire transmissions have for many years given good results, both those which include gravity stretchers and those which do not; but the addition of gravity stretchers makes further control and automatic blocking possible. The required degree of reliability of the switching gear is obtained by protective casings, by a suitable size of the weights and a suitable height of drop;

7° The locking of switches is only applied to a limited extent, apart from the control locking of switches which are far off;

8° Double-wire transmissions are exclusively used for the operation of signals at a distance;

9° The intercalation of control locks in the wire transmissions of signals is not quite without influence on the certainty of the operation; nevertheless it is frequently used in order to simplify the installations;

10° For the same reason, the operation of the distant and of the main signal is also frequently effected by one double-wire transmission only. Operation by two double-wire transmissions with separate interlocked levers, is more certain and hence preferred by sundry administrations;

11° It is absolutely necessary that the fracture of the signal wire transmission should result in the signal being at " danger ". Where gravity stretchers are used at all, they are generally also used to assist in producing this result;

12° The use of ball bearings and roller bearings in switch and particularly in

signal installations has proved advantageous; but as yet they are used only to a limited extent;

13° Electric signal arm interlocking has proved a valuable auxiliary in the case of mechanical installations;

14° Improvements in hand-operated installations are attainable and are to be expected, in reducing frictional resistances, in giving better protection against disturbing outside influences, in improving automatic controlling, locking and blocking appliances, as well as in the further addition of electric auxiliary appliances.

Power-operation.

15° Only electricity and compressed air with electrical control have given promising results as sources of power for the operation of large installations;

16° In individual cases good results have also been obtained by compressed carbonic acid, with electrical control;

17° Up to the present the number of failures is greater in the case of power-operated installations than in that of hand-operated installations. The former still want special expert maintenance and the capital outlay is greater than with the latter.

But with power installations a large amount of traffic can be dealt with more quickly than with hand installations; a number of safety conditions when operations are carried out at a distance can be satisfied better with the former than with the latter; in many cases the former also results in a saving of staff;

18° Their further extension at suitable places, especially in the case of new installations at stations with much traffic, is contemplated by those administrations who have tried them on a larger scale. The further development of such systems of power operation can therefore be looked upon as certain;

19° As regards the railways we are here considering, more experience is available about electric installations than about pneumatic. The question which of the two sources of power, electricity or compressed air, is to be definitely preferred, is as yet undecided;

20° Combination of hand-operated and power-operated appliances in one apparatus has been tried with fair success;

21° The simultaneous operation of the switches of a whole route, possible in power installations, is not effected and one limits oneself to operating each switch separately or operating two related switches simultaneously;

22° The electrical installations are operated with continuous current exclusively;

but the question of operating with single-phase or three-phase current is under consideration.

Signals and Switches generally.

23° The control of the completion of the operation of a signal at a distance is generally limited to the control of the "danger" and "line clear" positions. But there are also in use controlling devices with special checking for any doubtful intermediate positions;

24° The electric control of the position of the signal is as a rule not extended to distant signals, although these, from the point of view of their importance, have as a rule not less need for control than the main signals;

25° Spring switches can be set at a distance, in cases of hand-operation as well as power-operation, with as much certainty as ordinary switches;

26° The setting of barriers at a distance is often included in the route interlocking, that of level-crossing gates seldom;

27° The action of the train on the apparatus, by means of rail contacts and insulated rails, has given good results; this system has been applied extensively;

28° On the other hand, devices to enable the cabin to act on the train, so that a rail contact or treadle will produce a signal in the cab or will apply the continuous brake, are still in the experimental stage;

29° Opinions are divided on the question, whether it is desirable to apply the brakes in this way from outside;

30° Several administrations use sand tracks, the switches of which are operated from the cabin;

31° Electric track indicators have been successfully used for indicating the tracks at gravity sidings;

32° It has been proposed to set the switches automatically at gravity sidings with electrical operation.

Electric interlocking of route levers.

33° The electric interlocking of route levers (locking with electrical release) is very much preferred to purely-mechanical locking and unlocking;

34° The route interlocking is as a rule made dependent on other operations on the cabin in such a way that its operation is compulsory.

The co-operation of the train by means of rail contacts is utilized in this connection with advantage;

35° Electric interlocking gear works in most cases very satisfactorily with alternating current;

36° The locking of several routes by one single appliance (group locking) has been introduced in several stages of development and has given good results.

Prevention of the premature operation of switches.

37° The locking in position of a switch while a train passes, so as to prevent its premature operation by the signalman, is generally recognized to be desirable. This safety measure is most important in the case of switches taken from the facing side;

38° Pressure or contact treadles, partly combined with electrical appliances, are extensively used for this purpose, and with good results; time locks are used less, and some administrations object to these as unfavourable results were obtained with them;

39° Safety measures consisting of electrical appliances only (unlocking gear, rail contacts, insulated rails combined with electric lever locks) are used extensively for this purpose, and with success;

40° Reliable devices have been worked out for the fishjoints at the ends of insulated rails; in some cases they are combined with extra supports;

41° Where there is little traffic and only a small number of switches, good results are obtained by using control locks at the switches for locking them in position, with portable keys.

Graphic representation of the occupation of tracks.

42° Graphic representations of the occupation of tracks are as a rule not limited to platform tracks, but are generally also extended, the the form of plans of the traffic operation, to other entrance or departure tracks, the occupation of which is determined in advance in accordance with the time-table. They have proved particularly useful for the intercalation of special trains;

43° At some stations the occupation of the different tracks is shown in the office of the official managing the traffic by removable indicator plates. The marks appearing at the signal windows of the block apparatus also form, in a sense, a graphic representation of the occupation of the tracks.

[656 .257 & 656 .21 (01]

REPORT N° 3

(America)

By E. C. CARTER,

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A review of the conditions existing in the United States at the present time, with reference to the operation of switches and signals (II of section 3), develops the following :

A. — Centralized installations for operating switches and signals are limited :

First, to those in which the required movements of the functions are made by manual force through mechanical connections brought to a central point, and

Second, to those in which some form of stored power is controlled from a central point for such operations.

The first is represented by the mechanical interlocking mechanism which is in such general use throughout the world as to require no particular description. There has been, in America, very little, if any, change in the details of the apparatus or of its installation for a number of years. The use of 1 inch pipe connections is universal for the operation of switches, movable point frogs, draw bridge couplers, and their respective locks, compensated for the effects of temperature changes by an equalizing system of cranks and levers. It is also very generally used for the operation of home signals. Wire connections (one wire for the front connection and one for the back) are still used for the operation of distant signals which can be

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located not over 1,300 to 2,000 feet from the tower, but when the signal has to be located at a greater distance, liquid carbonic acid gas, stored in steel bottles, or electricity, derived from a battery, is used as the source of operating power, located at the signal and controlled electrically from the tower.

The second comprises those in which hydraulic, pneumatic, or electric power is stored and used for the operation of the various functions.

Owing to the severe climatic conditions which continue in winter for from two to four months throughout the northern portion of America the use of hydraulic switch and signal apparatus is subject to such derangement and such interruptions in operation as to be very unsatisfactory. A small number of plants of this type have been installed but have been discontinued and replaced by other kinds which are free from the troubles which are inseparable from the use of liquids as a means of power transmission under such climatic conditions.

The use of compressed air has been quite extensive and has given a very fair degree of satisfaction as the means for operating switch and signal installations in this country. This kind of power application is represented by two types :

a) The low pressure, in which the air is used at a pressure of from 15 to 25 lb. per square inch, and,

b) The high pressure, in which the air is used at from 80 to 100 lb. per square inch.

The low pressure type has many points of excellence, but for some reason has not become very popular, probably on account of the great number of pipes leading to the switches and signals. Inquiry developes the fact that no plants of this type have been installed since 1905 and also that, as the existing plants require extensive reconstruction or renewal, this type is giving place to some form of all-electric apparatus.

The high pressure type is represented only by the Westinghouse Electro-pneumatic system. A very large number of plants at large and complicated junction points and terminals have been installed and are in very satisfactory operation throughout the entire country. It is a recognized fact, however, that compressed air under high pressure is subject to a number of characteristic losses in efficiency, which will limit its use. The loss on account of the heat generated, due to the work of compression, is unavoidable and amounts to from 50 to 60 per cent of the energy expended in storing this kind of power. The losses due to leaks in the distributing pipes are variable but as the system grows older increase, and often become an element of serious expense, necessitating extensive repairs and renewals.

The application of all-electric interlocking plants has made rapid strides in the last eight or ten years and, as this type offers very superior advantages, it bids fair to take the lead. The reasons for this are :

1° Its greater flexibility in application and use;

2° In the storage of the power and its distribution the lossees can be reduced to a very small figure;

3° The distribution and application of the power is free from any inherent troubles due to variations or extremes of temperature.

This type of interlocking development is represented by the product of four principal companies.

The common feature in all of the designs is the use of motors for the movement of switches by means of gears, a screw, a worm or by a cam motion plate, any one of these mechanical devices being susceptible of development to meet the requirements. Signals are operated generally by motor driven gears, dwarf signals sometimes being operated by solenoids.

All power interlocking is arranged so that the completion of the movement of the switch or signal gives a return indication at the machine in the tower, releasing the mechanical locking and insuring that the position of the switch or signal, as the case may be, correspsnds with that of the operating lever.

The locking between the levers of the machine is mechanical, being generally of the same type as that for mechanical interlocking plants, though not made nearly so heavy, not being called on to withstand such applications of force as is usual in the manipulation of mechanical levers.

Electric locking of the levers in the interlocking machine may be arranged to effect the following in either mechanical or power operated plants :

Advance locking. — This is generally used at points where trains pass at high speeds, to prevent the taking away of the route which has been cleared for an approaching train, the switch levers remaining locked until the train has passed or until the signalman has operated a releasing device which is arranged to take time, thus repuiring deliberation and giving an interval during which the train can be stopped. The signal levers are never included in this advance locking but can, in their proper rotation, be restored to their normal positions at any time.

Detector bar locking. — Electric locking is used for this purpose in connection with track circuits in yards where such circuits are used in place of mechanical detector bars.

Route locking. — This form of electric locking is used to lock all switches in a route so that they cannot be moved in advance of a train after the train has accepted the route, even though the mechanical locking on the machine has been released by the leverman in placing his signal lever in the normal position.

Release route locking. — This form of electric locking effects the consecutive release of each switch as and after the rear of the train has passed it and is only used in large and complicated terminals to save time.

Check locking is that form of electric locking between adjacent interlocking towers which are so near each other as to call for co-operative action of the signalmen in them.

Route levers, as known in Europe, have never become popular in the United States, it being considered an essential operating requirement that the plant should permit of any possible route combination of switches being given so as to cover irregular movements and emergencies.

B. — The use of track circuits in place of detector bars has become usual in complicated terminals and is considered as being safer than any mechanical devices for this purpose, it being possible with such circuits to prevent the movement of the switches while the train is passing over them and may be arranged so that the train is wholly clear of any adjoining track or switch before another train can be permitted to pass that point. In plants where the spacing of the switches is such as to permit it, mechanical detector bars, either inside or outside of the rail, are still generally used, though it is evident that, with the increasing use of heavier rail sections which have materially wider heads, such use must be limited to bars of the inside type.

In heavily worked, large, and complicated terminals a miniature track model is generally provided on the interlocking machine for the information and convenience of the levermen. Formerly, this model was arranged to show the movement of the switches corresponding to the movement of the levers, but with the greater perfection of the return indication apparatus which controls the operation of completing the stroke of the lever, the model has been used to indicate the occupation of tracks or of two or more sections of a track as may be needed. An indication is often provided showing the failure of any train to wholly clear an adjoining track. One of the most complete and elaborate installations of this later type is that provided for the operation of the new Union Terminal at Washington, D. C. Each standing track in the depot has an independent track circuit fed through a resistance from a single supply circuit, the track relays all being in the tower at the outer end of the yard. In the tower and over the interlocking machine is arranged a large track model, covered with ground glass, on which the track arrangement of the station is outlined. So long as a track is unoccupied and is not fouled by cars on an adjoining track, that particular track on the model is illuminated from behind the glass. As soon as it is occupied by a car or train the lights are extinguished. It will be seen from this that these indications are given from a closed circuit, which is used preferably on account of its indicating at once any derangement in the circuits and is generally considered to be the only safe way in which track circuits for this or any other purpose can be used.

This station is also provided with a very complete system of communication between the director of the interlocking tower, the train conductors on the different departure platforms and the gateman controlling the admission of passengers to

those platforms. In the interlocking tower, in front of the director, there is a bank of indicator lights arranged one above the other, three for each track, the upper light being the return indication from the train conductor, the middle light an indication to the conductor and the gateman, and the lower light an indication from the gateman. Adjoining each gate there are two incandescent glow lights on the circuit, one above the other, connected in such a way that the gateman, by inserting a special key, can complete a circuit to the tower.

At four points, distributed along the platform, are located boxes on the columns supporting the umbrella shed, each box having two glow lights, one above the other, the boxes being so arranged that the conductor of a train, by inserting a special key, can likewise complete a circuit with the tower. The method of using this system of communication is as follows;

One minute before the departure time of the train, the conductor inserts his key in one of the boxes on the platform and turning it closes the circuit which lights the upper light for the corresponding track in the bank of lights in front of the tower director and likewise lighting the upper of the two glow lights at the gate. If the director is ready to have the routes given for this train, he presses a button which puts out the top light given by the conductor and lights the one next below it and lights the top light in each of the boxes along the platform and puts out the upper and lights the lower of the two lights at the gate. When the time has arrived for the train to go, the gateman closes his gate and with his key puts out the light at the gate. This also puts out the upper and lights the lower of the tower indicator lights, in this way advising the conductor and the towerman simultaneously that the train may leave. The conductor may then give his usual starting signal to the engine runner to go, which he then does, provided the proper fixed signal is clear. This arrangement provides a very simple and accurate system for transmitting the required information and works perfectly.

C. — The use of diagrams for facilitating the full utilization of tracks along passenger platforms.

Inquiry of the roads in this country having the largest terminals developes the fact that no such diagrams are used or are considered as being necessary for the distribution of trains at platforms, experience having proved that the familiarity of the director in the tower with the station lay-out and the information which he receives in advance as to the trains to be handled is such that the desired results can be better obtained by relying upon his skill.

The foregoing covers about all of the points that are raised by the questions which are submitted for discussion, but it is believed that in this same connection it will be interesting to present a discussion which has been under consideration by those interested in signalling of the various railways of the United States during the last three years. In general, the practice in America has been to give the indications of fixed semaphore signals for both interlocking and automatic block signals, in the

lower right hand quadrant, usually by two positions, the home signal being horizontal for " stop " and diagonally downward or vertically downward for " proceed ", and the distant or caution signal (the end of the blade being of a different form from that of the home signal, being notched or fish tailed, whereas the end of the home signal is square) indicating in the horizontal position "caution" and diagonally downward or vertically downward indicating " clear ". The extensive application of automatic semaphore block signals and the attempt to carry the block working through more or less complicated interlockings has led to considerable diversity of practice on different lines, and the automatic block semaphore, both home and distant, being of the same form as the home and distant semaphores for interlocking plants has led most naturally to a possible confusion on the part of the engine runner in the interpretation to be given for a given signal indication, especially when in its normal position, which, for an interlocked semaphore indicates " stop and stay " and for an automatic block signal semaphore indicates " stop and proceed with train under control ". The practice on different roads in connection with interlocked semaphores at points where a number of routes are to be indicated has also varied, a number of the older lines having a home signal blade for each route, placed one above the other on a single mast, and other roads for similar situations having only two, the upper for the main high speed route and the lower for diverging routes.

Figure or letter indicators combined with the lower blades, under the two blade system have been tried but were discarded as of no value corresponding to the complication or cost due to their use.

The consolidation of different railway properties under one management has brought together lines having both systems in use and the necessity for unifying the practice over the whole of such a consolidated line and doing it in such a way as would provide for the future as well as the present requirements led to a very prolonged and exhaustive investigation by Committees appointed by the larger lines interested in the question, and later by Committees of Railway Signal and Maintenance of Way Associations. The result of these investigations was the statement of a series of fundamental principals and of the rules which should govern any applications under those principals.

The first and most radical departure was the use of the upper right hand quadrant for giving signal indications, in this respect following the German practice.

Secondly, the giving of three indications by one signal blade, one by the blade displayed in a horizontal position and pointing to the right, one by the blade pointing upwardly at an angle of 45° and one by the blade pointing in a vertical direction upwardly.

Thirdly, the use of a second blade below the first, which in turn gives three indications by similar positions to those of the first or upper blade.

Fourthly, the distinguishing of interlocked semaphore signals from automatic semaphore signals by having the ends of the interlocked signal blades (when the blades were in a horizontal position) in the same vertical line, and by having the

ends of the automatic semaphore signals (when the blades were in a horizontal position) so arranged that the upper blade projected further to the right than the lower blade.

The night signal lights were correspondingly arranged, one being vertically above the other for interlocked signals and for automatic signals the lower light being located diagonally below and to the left of the upper light.

The above combinations of three positions for two signals permitted of giving a considerable number of indications which were thought necessary for giving information to direct the movement at the high speeds at present required for through limited and special service trains.

It is generally admitted that the night indications should be given by lights of distinctive color, and the difficulty in giving so many combinations as above required has been solved by the use of green, yellow and red lights for the three positions of vertical, 45 degrees, and horizontal, though it appears to the writer that by far the most logical solution would have been green, red and green, and red for the corresponding positions, the red and green from one source of light having been proven by years of use on one or two of the largest systems in the country to be absolutely distinct and reliable.

Up to the point where two blades have been decided on for giving indications in combination, there has been a fair degree of unanimity in the ideas of those responsible for the system, but some divergence of opinion has developed as to the system by which the combinations shall be made and the great danger appears to be that greater confusion may result as between the practice of different roads in this respect than has existed under the systems which have been in use heretofore.

It is the writer's personal opinion, that simplicity should never be sacrificed in so grave a matter as giving indications for governing the runner of high speed trains, in order to give modifying instructions for slower speed movements. The time for correct action by the runner of a high speed train is so short that the message to be conveyed by signals must be so simple that its interpretation is intuitive and not the result of reasoning. The message, therefore, must be limited to that which can be instantly comprehended by any one who can be expected to reach the position of runner and not by the highest, or even the average mental development to be found in runners as a class. It is the firm conviction of the writer that, taking into consideration all of the conditions surrounding the men whose duty it is to run an engine, the care of the machinery, the looking out for train order, block, and interlocking signals, the graduation of power for grades and curves, taking water at speed, station stops, and a great many other exacting requirements, that the placing upon them of the responsibility of correctly interpreting a combination of signal indications which takes a variety of mental operations, is a long step away from safe practice. It would seem much safer to give the indications by one blade, which, if need be, can have four positions with corresponding night indications, four appearing to cover all present requirements, the blade pointing to the right of

the signal mast as seen by an approaching train whose movement is to be governed by it.

1° The blade in a horizontal position, red light at night;
2° The blade vertically upward, green light at night;
3° The blade inclined upward at an angle of 45°, a red and green light at night;
4° The blade inclined downward at an angle of 45° a yellow light at night.

The corresponding indications would then be as follows :

1° Stop signal;
2° Clear signal. Proceed. Next signal is also in position to be passed, being either clear or at caution;
3° Caution signal. Proceed at such speed as will admit of stopping at next signal, which may be at stop or at caution;
4° Caution signal. Proceed at such limited speed as is safe to take a diverging route from the main line from this junction or cross-over.

As discriminating between semaphores for interlocking and those for automatic block signals, there can be placed upon the mast a bracket projecting to the left, whose outer end shall have the same relation to the mast that the outer end of the semaphore casting has to the left of the mast for interlocked signals, and on the outer end of which a white light can be placed at night as a marker. For automatic block semaphores this bracket can be projected further to the left so that its outer end will appear to be materially further from the mast than is the semaphore casting upon that side and on the outer end of which a white light can be placed at night as a marker.

It is believed that such an arrangement of signals as this can be made to cover all of the necessary moves in territory where high speed is permitted and that in terminals or other points where the speed is necessarily limited, as compared with that on the open road, a dwarf signal indication can be given on the ground at the foot of or below the high speed signal to meet any additional requirements as to movements of trains at such points.

It will be seen from the above that the mental operations which the high speed runner would be obliged to carry out are limited to not more than four at the instant that he observes the signal, his rule being :

1° Stop if a red light or a horizontal blade is displayed;
2° Run if a green light or vertical blade is displayed;
3° Reduce speed as is necessary if a red and green light is displayed, or the blade is pointing 45° upwardly;
4° Reduce speed if a yellow light is displayed or the blade is pointing 45° downward.

Having got his train under control, he then has ample time to further consider the movements which correspond with the kind of signal and with the location on the road. The diagram given hereafter illustrates the system as proposed by the Railway Signal Association and that suggested by your reporter.

As a matter of information in connection with the use of interlocking and block signals in the United States, the following statement will prove most interesting.

During the last two years, a wave of legislation has passed over the United States having for its aim the compulsory use of electric head lights on locomotives and, although the Railway managements presented the strongest arguments against such a requirement, many of the states passed the bill and made it a law.

There is no doubt but that the use of the electric head light largely diminishes the distinctive character of night indications of block and interlocked signals. On lines of single track the condition will be serious enough but where there are two or more main running tracks the electric light blinds the runner of an approaching train on an adjoining track so that for an appreciable time after having met the train the eye cannot tell one colored light from another. It is a question still undetermined whether the continued repetition of this blinding effect will not seriously impair the vision and thus reduce the period of the runners safe employement on lines where the highest speed trains are guided wholly by block and interlocked signals. While there is no chance for a repeal of this law for one or two years in those states where it has been adopted it is hoped that other states will not follow their example and that experience will lead in due time to the elimination of this unfortunate and even dangerous legal requirement.

Summarizing the situation as regards interlocking in America:

Application of power interlocking is rapidly increasing;

Electro-pneumatic and purely electric systems are superseding all other forms of power interlocking;

The track circuit, with electric locking, is superseding mechanical detector bars;

All forms of electric locking are being generally used in connection with heavily worked terminals and in heavy traffic territories;

Diagrams for facilitating the full utilization of tracks along passenger platforms are not used in the United States.

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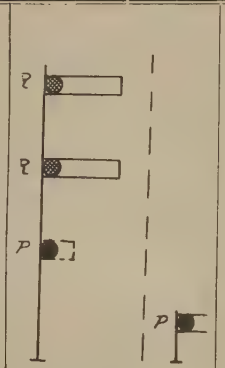
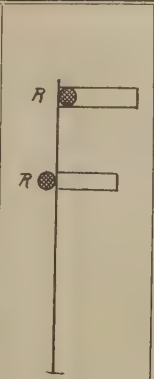
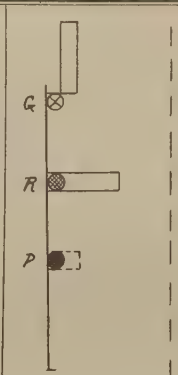
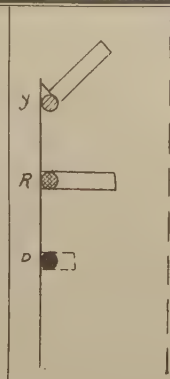
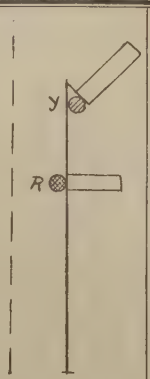
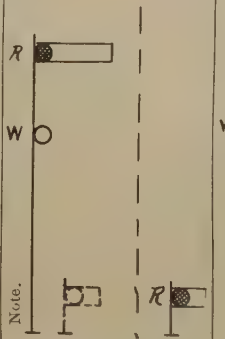
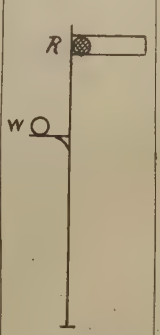
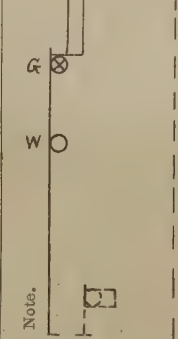
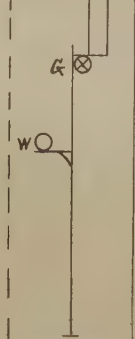
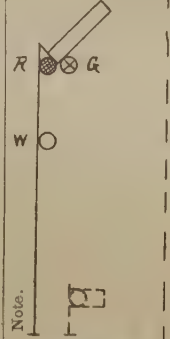
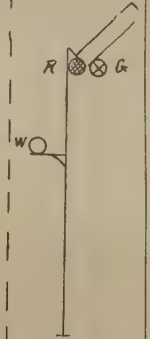
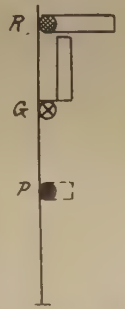
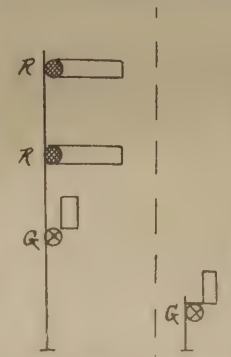
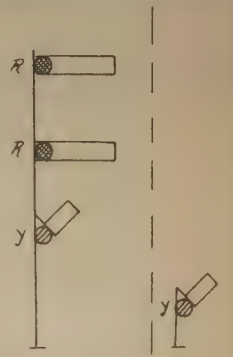
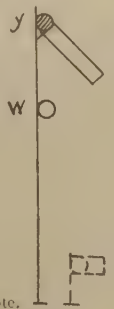
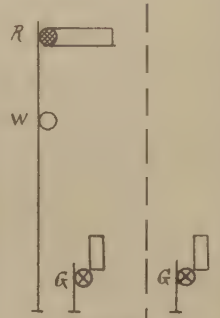
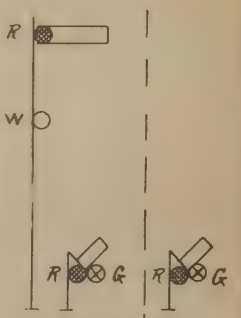
Recommended by Railway Signal Association. Report of 1909.	 Interlocking signals.	 Automatic block signals.	 Interlocking signals.	Automatic block signals.	 Interlocking signals.	 Automatic block signals.
Recommended by your Reporter.	 Interlocking signals.	 Automatic block signals.	 Interlocking signals.	 Automatic block signals.	 Interlocking signals.	 Automatic block signals.
R = Red light .... G = Green light .. Y = Yellow light. P = Purple light. W = White light.. LW = { Lunar white ligth.	Stop. *Note.* — When used in conjunction with a high home signal the light of the Dwart signal corresponding to the stop indication will be shielded off.	Stop-then proceed.	Proceed.		Proceed prepare to stop at next signal.		Do not think this is required.		Proceed-prepare to pass next signal at limited speed.	

Recommended by Railway Signal Association. Report of 1909.						
Recommended by your Reporter.	Do not think this is required. Interlocking signals.	 Note. Interlocking signals.	Do not think this is required. Interlocking signals.	Dot not think this is required. Automatic block signals.	 Interlocking signals.	 Interlocking signals.
	Proced-prepare to stop short of any obstruction in the block.	Proceed at limited speed.	Proceed at limited speed-prepare to stop at next signal.	Proceed at limited speed-prepare to stop short of any obstruction in the block.	Proceed at low speed.	Proceed at low speed-prepare to stop.

[656 .257 & 656 .21 (01]

REPORT N° 2

(Holland)

By L. H. N. DUFOUR,

ENGINEER TO THE COMPANY FOR WORKING THE NETHERLANDS STATE RAILWAYS.

SECTION A.

CHAPTER I.

The operation of points and signals by hand levers.

a) Introduction.

The signalling arrangements on the Netherlands Railways conform to the bye-laws and regulations of 1875. These regulations require that stations, junctions and swing-bridges should be protected by signals placed at about 300 metres (328 yards) in advance of them. The setting of the signals protecting a station should be under the control of the station-master. The signals which protect swing-bridges should be interlocked with the mechanism for wedging and locking the bridge.

Except in such cases as have been passed as exceptional by the Minister of Railways, the position of the points is shown by a signal.

Although these bye-laws and regulations only require simple appliances, the Dutch Railway Companies, profiting by the experience of neighbouring countries,

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have not failed to improve their signalling systems, so that on all leading railways we now find the points interlocked with the signals and the operating gear usually centralized.

The Dutch Railways are worked : *a*) by the Company for working the Netherlands State Railways (hereinafter designated by the letters N. S. R., about 1,800 kilometres [1,120 miles]) ; *b*) by the Holland Railway Company (H. R.), about 1,300 kilometres [800 miles]); *c*) by the Central Netherlands Railways Company (C. N.), and by that of Boxtel-Wesel (B. W.), each of which only works about 100 kilometres (62 miles).

There is a considerable difference between the signalling systems employed and also between the apparatus used on the N. S. R. and on the H. R., but the C. N. and B. W. Companies use apparatus of the type used on the N. S. R.

According to the bye-laws and regulations, the signalling system in use before 1883 consisted only of distant disk signals worked on the single-wire system, by means of levers placed some near the station offices and some near the outermost points.

In some stations, the distant signal levers worked from the cabin at the outermost points were blocked by the signalman and unblocked by the station-master by means of the Siemens & Halske apparatus. The German firm had been entrusted with the complete installation of the first sets of apparatus, and had at the same time replaced the distant disks of French origin by semaphore masts with lifting arms of the German pattern.

At some of the junctions, a more complex apparatus, of English origin, was in use : the points were operated by rodding, and the signals by single-wires.

To effect an economy in the staff, and on the initiative of Mr. van Hasselt of the H. R., Mr. Taurel, the Engineer of this Company, constructed and installed in 1883 double-wire apparatus of strong construction for the operation of points at long distances (400 metres [437 yards]). These appliances, described in the *Revue générale des chemins de fer* (1), are the predecessors of all centralized systems of wire-operated apparatus used in the Netherlands.

The appliances for operating and bolting the points, the signals and the transmission gear, have been considerably modified since this date. The general principles of the construction and the use of a wire-transmission, without special arrangements for compensation for variation in temperature, have nevertheless been retained.

Centralization effected by means of rodding has been entirely abolished; the cost of up-keep was enormous in comparison with that of the wire-transmission. It was, moreover, difficult to maintain the rodding in good working order, and to be sure that the points were brought home against the stock-rails in the marshy and shifting lands of Holland. The operation of the signals by single-wire caused so

(1) No. 4 of 1886, p. 217.

much trouble that is was replaced by the double-wire system, even in the case of the English apparatus many years before this latter was abolished.

The general form adopted for the protecting signal was the semaphore with a straight lifting arm. This arm terminates in a semi-circle of radius equal to the width of the arm. The stop signals are situated 300 metres (328 yards) in advance of the danger point, in those cases in which there is no distant signal. When the stop signal is preceded by a distant signal, distant 450 to 500 metres (490 to 546 yards) from it, the stop signal is placed 100 metres (109 yards) from the danger point on the N. S. R. and 150 metres (164 yards) from the danger points on the H. R.

On the H. R. all points are provided with a ground-signal with lantern, of small size, whereas on the N. S. R. a signal is only used at the outermost points; this has a height of 3·20 metres (10 ft. 6 in.). It shows by a rectangular arm measuring 950 × 340 millimetres (3 ft. 1 $^3/_8$ in. × 1 ft. 1 $^3/_8$ in.), and by a white light, that the points are set for the main line and by a circular disk 750 millimetres (2 ft. 5 $^1/_2$ in.) in diameter, and by a green light, that the points are set for the branch line.

The N. S. R. scarcely ever uses a distant signal with two arms to show the different tracks leading into a station, but considers a home signal at the station and a clearly visible signal at the outermost points sufficient indication for the purposes of the drivers; the H. R. frequently uses candelabra posts, with two masts, each fitted with an arm, the top arm relating to the main line and the other to the branch line.

When the signals at the entrance to a station are not easily visible, and on lines with heavy traffic, the signals at the entrance to the station are preceded by distant signals.

The distant signal consists of a caution semaphore-arm placed at a height of about 9 metres (29 ft. 6 in.), with the end of the arm cut off square. This arm, which is inclined at 45° downwards (or shows a green light at night), requires slacking, whereas, when inclined 45° upwards (or showing a white light at night), gives " line clear ".

The signals which are situated between the outermost points of a station on the N. S. R. are not generally preceded by distant signals. The instructions require that signalmen should only give the " line clear " signal on distant signals under those conditions when the succeeding stop signals at a distance of about 800 metres (875 yards) are also set to " line clear ", or after having ascertained that the train has slacked or has stopped before the distant signal.

When the atmospheric conditions prevent the signals from being seen, the signalman must ascertain the position of the succeeding signal by means of the telephone.

The H. R. does not follow this rule, and has extended the use of distant signals at stations.

On the H. R. the signals at the entrance to a station and the signals protecting junctions, swing-bridges, etc., are preceded by a fixed optical indicator called a

beacon, placed 850 metres (930 yards) in advance. This indicator consists of a plate 1·50 metres (4 ft. 11 in.) in height, and 0·75 metre (2 ft. 5 1/2 in.) in width, painted in black and with chequer pattern and placed against a post having a height of 2·50 metres (7 ft. 4 5/8 in.). This indicator serves to notify the driver of the train that he is approaching the signals particularly in the case of fog.

The same reason has led the N. S. R. to place attention boards (beacons) on some of their lines in advance of the home signals; these attention boards consist of three planks about 5 metres (16 ft. 5 in.) in length; they are painted white, are slightly inclined, are spaced about 10 metres (32 ft. 10 in.) apart and are placed at a height which increases from 1·50 metres to 3 metres (4 ft. 11 in. to 9 ft. 10 in.) above the rail level (1).

The small stations on the N. S. R. and on the H. R., which have two or three crossings, or passing loops in the case of single-tracks, are now nearly all fitted with a lever frame, arranged near the station offices. The apparatus consists usually of four or six levers connected to the outermost points and to the stopping signals. The settings of the intermediate points which give access to the goods bays and sidings are determined by locks, the keys to which are interlocked with the lever frame on the N. S. R. or by means of point bolts on the H. R.

The distance between the outermost points and the hand lever is sometimes as much as 550 metres (600 yards); the position of the points, worked at a great distance from the frame, is confirmed by a bolt (detector) inserted in the connections to the signal.

So soon as the traffic on a single track becomes fairly heavy, each of these companies provides starting signals, in some cases a signal for each track by which a train can leave.

Those single tracks on which fast trains are run have been fitted in recent years with single-track block apparatus on the Siemens & Halske system; in this case, the starting signals are interlocked with the block apparatus. A combination which is analogous to the starting signals and electric block apparatus is very frequently provided on the N. S. R.; this makes the setting of the starting signals dependent on certain appliances situated on the track, such as the wedging gear of swing-bridges, points giving access to sand-pits, loading sidings, etc.

The signalling arrangements and frames at small stations, which we have just described, have some disadvantages : 1° in the event of error being made by the station-master a train can enter on a line already occupied by another train; 2° at stations where trains pass each other it is almost impossible to verify whether the

(1) Special precautions are taken, moreover, in time of fog. The trains are kept further apart so that they are separated by at least one block section. Detonators are placed in advance of or near to, the signals by employees specially chosen for this duty. Telegraph or telephone messages are exchanged relating to the positions of swing-bridges, etc.

whole of a train entering the station has arrived (without any breaking away) before permitting the departure of a train in the opposite direction; 3° the operation of points situated at a distance greater than 200 metres (219 yards) from the frame presents certain difficulties.

The first disadvantage can be overcome by electrically insulating one of the station tracks and employing a gear which prevents the home signal being put to " line clear " when the track ceases to be insulated; the H. R. has installed such arrangements in some stations; these will be described further on (see appendix V).

This disadvantage may also be to some extent avoided by interlocking the starting signal for each road with the home signal for trains arriving from the opposite direction. The interlocking of the hand levers operating these signals must satisfy the following conditions: 1° the home signal A, permitting arrival on the road *a*, can only be set to " line clear " when the home signal B, and the starting signal C, for trains arriving from the opposite direction, on the same track *a*, are at danger; 2° after the home signal B has been again set to " danger ", it is impossible to pull off the signal A, until after the starting signal C has been pulled off and again set to " danger ". The N. S. R. have adopted this method in several stations.

It is impossible to avoid the second disadvantage without installing special cabins at the outermost points.

To obviate the third disadvantage, we have had some appliances arranged with a key, which enabled the points to be disconnected from the transmission gear when the lever was in a certain position, so that the points could be operated at the spot. These appliances did not come up to expectation; the staff preferred to operate the points from a distance to avoid the constraint and running about which always accompany these combinations.

In the case of more important stations, as well as on stations with direct access to sidings on double-tracks where the points are taken facing, centralisation in a single frame placed near the station offices is but rarely employed, because as the distance between the points becomes greater and greater, there is a corresponding increase in the disadvantages already enumerated.

Although the cost of the installation is greater and although the staff required is more numerous, a cabin has been erected at each end of the station. When it is not desired to fit insulated track sections, it is found that the traffic can be worked better when the necessary operations for authorising a train to pass are divided between two people. These two employees can keep a check on each other.

Moreover, the signalman in cabins at the ends of the station can ascertain whether the whole of a train (without breaking away) has entered a loop; this is an impossibility in the case of the employee situated at the centre of a station.

The wood or brickwork cabins, with the floor at a level of 2 metres (6 ft. 6 3/4 in.) above the rails, in this case contain a frame with levers for operating the points, the home and distant signals and the starting signals. The signal levers are interlocked by means of the electric apparatus of the block-system.

On the N. S. R., the two cabins A and B have these block-instruments slotted direct with each other, whereas the H. R. has inserted the block apparatus in the station-master's office between the block instruments of the outer cabins.

On the N. S. R. the signalman at cabin A demands, by means of an alarm, of the signalman in cabin B, road clear for a train proceeding from A to B; the signalman at B gives him " line clear " on the track corresponding to that demanded on the electric block-apparatus, and the signalman at A can only pull off his home signal when his points have been set to make the road cleared by cabin B.

For trains proceeding in the opposite direction, the signalman at A similarly gives " line clear " to the signalman in cabin B; of course the block instruments are inter-connected in such manner that it is impossible for both to put their home signals to " line clear " for the same track.

One of the cabins is considered the chief cabin; this cabin is fitted with telegraph apparatus giving comunication with the other telegraph station on the line. In case changes in the train service are necessary, the employee in the chief cabin notifies the station-master by telephone and informs the signalman in the second cabin.

The electric block-system apparatus for the main line is fitted in the outer cabins in such manner that the signalman are in direct communication with the adjacent cabins; this block-apparatus is generally connected to the block-apparatus at the station. On the H. R. the block-system for the main line is operated from the stations-master's office; the stations-master gives " road clear " for a train arriving at his station on any given track, and he also gives " road clear " for the departure of this train. He is in telephonic communication with the cabins on the main line; the signalmen are, therefore, completely under his control.

On the N. S. R., in some cases, one of the cabins is placed near the station offices and one of the employees in this office fulfils the functions of signalman; as a rule, there are always two employees who must act in agreement with each other to effect the necessary manœuvres for the working of the traffic.

To secure an economy in the staff, the site of the cabins is selected, whenever possible, near to a level crossing, even though the points may be 250 metres (273 yards) distant; the barriers at the level crossing are worked by the signalman.

On the N. S. R. the block-apparatus on the main line stands normally at " line blocked "; that is to say, a signalman cannot pull off his signal till after the road has been cleared from the succeeding cabin in reply to a demand made by means of the electric alarm. This cabin cannot give " line clear " to the preceeding cabin unless he has blocked the line in the rear of the last train.

On some lines of the N. S. R., as on all the lines of the H. R., the system of " line normally clear " is still to be found, although the signals stand normally at danger; the signalman can set his signal to " line clear " provided he is not blocked for a train on the succeeding section of the track.

The N. S. R. has preferred the system of " line normally blocked ", although the expenses are relatively greater.

1° For enabling the unblocking to be operated over a second section and thus to increase the distance between the trains in time of fog;

2° For enabling the signalman to allow shunting operations to be performed with safety on the section of the main arrival line in advance of the home signal; the signalman can protect such operations by keeping the line blocked to the preceding station.

In stations covering a large area, large cabins with a great number of levers are frequently found. There is no objection to operating points at a distance of 400 to 500 metres (437 to 547 yards) from such cabins, when these are only used by the regular traffic and when they are but seldom employed in shunting operations. A distance of 250 metres (273 yards should not be exceeded in the case of points which are frequently used by such trains. The difficulties which arise when this distance is exceeded may be met by fitting an alarm push-button near the points; by means of this alarm the making of the road can be demanded of the signalman.

As usual, all the passenger tracks in stations are used for all roads on the N. S. R. as well as on the H. R.; frames exist which contain sixty to seventy levers, with a large number of small hand route-levers; it follows that the length of the frame may sometimes exceed 10 metres (32 ft. 10 in.).

It is almost always desirable that the floor of the cabin should be placed at a considerable height; this height varies from 4·50 metres to 7·50 metres (14 ft. 9 in. to 24 ft. 7 in.) in the large cabins on the N. S. R.; the preliminary erection of a scaffold to determine the best situation and the most suitable height for the cabin has given good results.

In some cabins, hot water heating has been applied with success.

On the N. S. R., in the zone of operations of the cabin, the tracks are protected by semaphores against trains arriving by main lines and by disks against trains arriving from branches; these signals apply to the drivers of the regular trains, and also to those performing shunting operations. The drivers of trains on starting must notice, in addition to these signals, the starting signals at the end of the station giving the road.

By employing the fixed signals for shunting operations, the trains and locomotives can run through the station at a higher speed than would be possible if point indicators and portable signals were used.

The traffic on passenger tracks, and on the chief goods roads between the two cabins, is controlled by signals. Their position depends always on the positions of two levers in the two cabins, or else the lever in one cabin is slotted by the other cabin through the intervention of an electric block station apparatus. In the case of the other tracks, permission, given by telephone, must precede the arrival of the train in the zone of the cabin.

The block signal on the main line consists of a semaphore placed about 50 metres (54 yards) beyond the outermost points (1). This signal may also serve to give the road.

On the H. R., on which the signals only control the regular train service, the system of special signals for shunting has been greatly extended. These signals consist of a pair of arms at the top of a post: if the two arms are placed at right angles to the direction of the tracks, and if a violet light shows at night, shunting operations may be performed, but if the two arms are parallel to the direction of the tracks and the light is not visible, shunting operations may not be performed.

Whereas on the H. R. all the necessary measures are taken for the arrival and clearing of the trains from the central cabin, the central cabin on the N. S. R. only deals with ordinary trains entering its zone, and with goods trains which in entering or leaving may hinder the working; thus the signalling on the H. R. is, as in Germany, more centralized in the hands of a single employee. The N. S. R. system resembles more closely the English or Belgian systems, which give more freedom to the signalman. In both systems the chief responsibility, which consists in ascertaining whether the roads are clear or blocked, rests with the same employees. In the German system of the H. R., the operator in the central cabin can only ascertain whether the roads are clear or blocked by the aid of the signalman.

b) Lever frames.

The apparatus for operating the signals and points in the Netherlands at the present time, may be divided into three classes. Class No. 1 which is of fairly simple and strong construction does not lend itself well to combination with the block apparatus, whereas classes No. 2 and No. 3 allow this apparatus to be so fitted that the levers are controlled by an electric slot system.

The strong construction of class No. 1, as well as the simplicity of its parts, permits of its being fitted in the open. The locking bars being only six in number, it does not lend itself well to the arrangement of a large number of interlocked levers.

The apparatus consists of a certain number of pulleys, each carrying its lever, and turning about a common axis. The rim of the pulley is grooved, and the chain which forms a portion of the wire-transmission, is fastened in this groove. In its normal position, the lever is thrown back and stands at an angle of 20° to the vertical; when pulled over the lever is horizontal; in operating the lever, the hand moves through a distance of 1·50 metres (4 ft. 11 in.), corresponding to an angle of 110° moved through by the pulley and to 500 millimetres (1 ft. 7 $^{11}/_{16}$ in.) travel of the chain.

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(1) Vide *Bulletin of the Railway Congress*, No. 8, August, 1908, p. 843.

The pulley shaft is carried on pedestals; there is one pedestal at each end and an intermediate one after the fourth, eighth and twelfth pulleys; the apparatus is never used for more than sixteen levers.

The details of the apparatus were described in the *Bulletin of the International Railway Congress* (1).

The lever apparatus of class No. 2, generally in use on the N. S. R., is of the Siemens & Halske pattern; the appliances are constructed either in Berlin or at Alkmaar, near Amsterdam.

The frame, the length of which depends on the number of hand levers, is carried on two supports when the number of levers does not exceed twenty-one and the length is not over 2,300 millimetres (7 ft. 6 9/16 in.).

For a greater number of levers, the frames are placed against each other; the interlocking bars of the different frames are joined by connecting pieces.

We give, further on (appendix I) a description of these appliances.

The lever frames of class No. 3, in general use on the H. R., are manufactured by the " Alkmaarsche Yzergietery " at Alkmaar. They are described in appendix II.

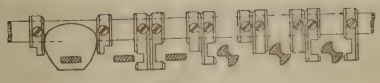

Fig. 1.

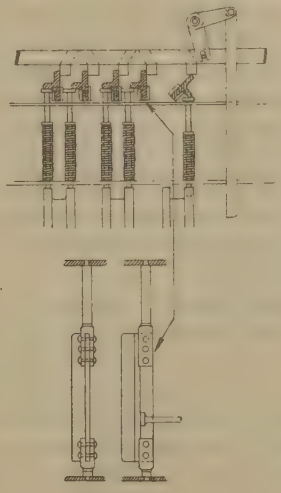

Fig. 2.

The interlocking arrangements in apparatus of classes No. 2 and No. 3 consist of shafts which carry tappets acting, between the bars, on pins fixed on one side of the bars; in large frames, this gives rise to much difficulty when any modification

(1) Vide *Bulletin of the Railway Congress*, No. 10, October, 1908, p. 1105,

is required. In order to fit or to remove tappets on any shaft, the whole of the bars and the shaft affected have to be taken down. This operation is difficult, and it is dangerous to perform it while there is traffic; for this reason, in the Siemens & Halske apparatus of recent construction as well as in the Alkmaar apparatus, the shafts are replaced by rocking bars of special section which act on tappets bolted or screwed to the bars.

Figure 1 shows diagramatically the new mechanical interlocking gear in the Siemens & Halske apparatus, and figure 2 shows a similar method applied in the Alkmaar apparatus.

Its is interesting to note that these methods are very closely similar to those adopted by Messrs. Saxby & Farmer over thirty years ago.

c) Appliances for operating and bolting the points.

On the N. S. R. and on the H. R., prior to 1895, the point-tongues, in the case of points operated from a frame, were connected to each other by two or three rods; the movement of the parallelogram formed by the tongues and rods was effected by the rotation of a specially formed cam. This cam was carried on a vertical axis, and was of the shape of two circular arcs having the same centre but unequal radii; the two circular arcs were connected by suitable transition curves. The rotation of the cam gave a to-and-fro movement to the crossbar connecting the point-tongues.

The movement of the apparatus may be divided into three periods corresponding respectively to successive angles of 45°, 120° and 45° of rotation of the pulley. In the first period unbolting is effected; during the second period (of 120°), the disk acts on rollers and the point-tongues are thrown over; the bolting of the points is effected during the third period.

The apparatus of the N. S. R., of which over 800 are still in use was described in the *Revue générale des chemins de fer* (1).

To avoid damage occurring to points fitted with this apparatus in the event of running through from the trailing side when wrongly set, the crossbar was weakened in the centre, so that it bent or broke at this part.

This arrangement has a well-known disadvantage, which can be to some extent overcome by the use of fixed signals on all the roads made by the points in question and by the use of bolt-locks connected to the signal transmission gear.

In more recent installations, it has been preferred to fit shunting points of German origin; in these, the point-tongue which is pressed against the rail is bolted, while the other tongue, although connected to the operating and the transmission gears, is, in the case under consideration, free to follow the action of the wheels by disconnecting the pulley from the operating lever in the central frame.

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(1) January 1891, p. 30.

Nevertheless the N. S. R. and the H. R. prefer the type which cannot be run through trailing when wrongly set at places where running through is unlikely; for example where no shunting operations are carried on, at junctions, etc.

We are of opinion that a system with rigid point-tongues is preferable when it can be applied without disadvantage. In nearly all the points, one of the tongues guides the wheel while running on a curve, and it is certain that this tongue can better resist the forces acting on it if it is locked, as in the old appliances, than when it is free, as in the new.

By acting as a check-rail, the tongue is subjected to shocks as each wheel passes, and these blows, although transmitted through the point gear and transmission gear, produce rather rapid wear of the operating gear.

The appliances used for operating points in Holland are described in appendix III.

d) Flexible-tongue points on the H. R.

The H. R. is, at the present moment, fitting points on its main lines in which the point-tongues are of planed rail and are fished to the succeeding rail length; they are also firmly connected by cross-stays with the stock-rail over a portion of their length. This point-tongue is moved, not by pivoting on its heel, but by bending over a part of its length which is planed on both sides of the sole. The point-tongue bears against the stock-rail when it is free. To move one of the point-tongues to make a road, it is necessary that the tongue which is drawn back must be acted on by a force. When fully drawn back, it acts as a spring and tends to return to its normal position.

When points which may be run through trailing while wrongly set are fitted with these tongues, the gear is subjected to the action of this force which tends to move it bodily. This form of construction can only be allowed to be used when precautions are taken against the effect of this force.

The H. R. has adopted an arrangement shown in figure 3. It consists of a system of spiral springs A, placed between the tongues and connected to levers which are pivoted at one end on pins C, carried from the sleepers.

The other ends of these levers are connected to the tongues by rods D. The ends of the springs slide in the slotted holes formed in the levers; the system of rods, levers and springs is so arranged that the springs only act on the tongue which is drawn back. The action of the spring thus compensates the force referred to.

For actuating the flexible tongue-points the H. R. sometimes employs a well-known German system which can be readily understood from the drawing (fig. 3).

e) Signals.

The semaphores on the N. S. R. are made of steel plate; the arm, which is of iron or of aluminium for distant signals, is placed at a height of about 9·50 metres

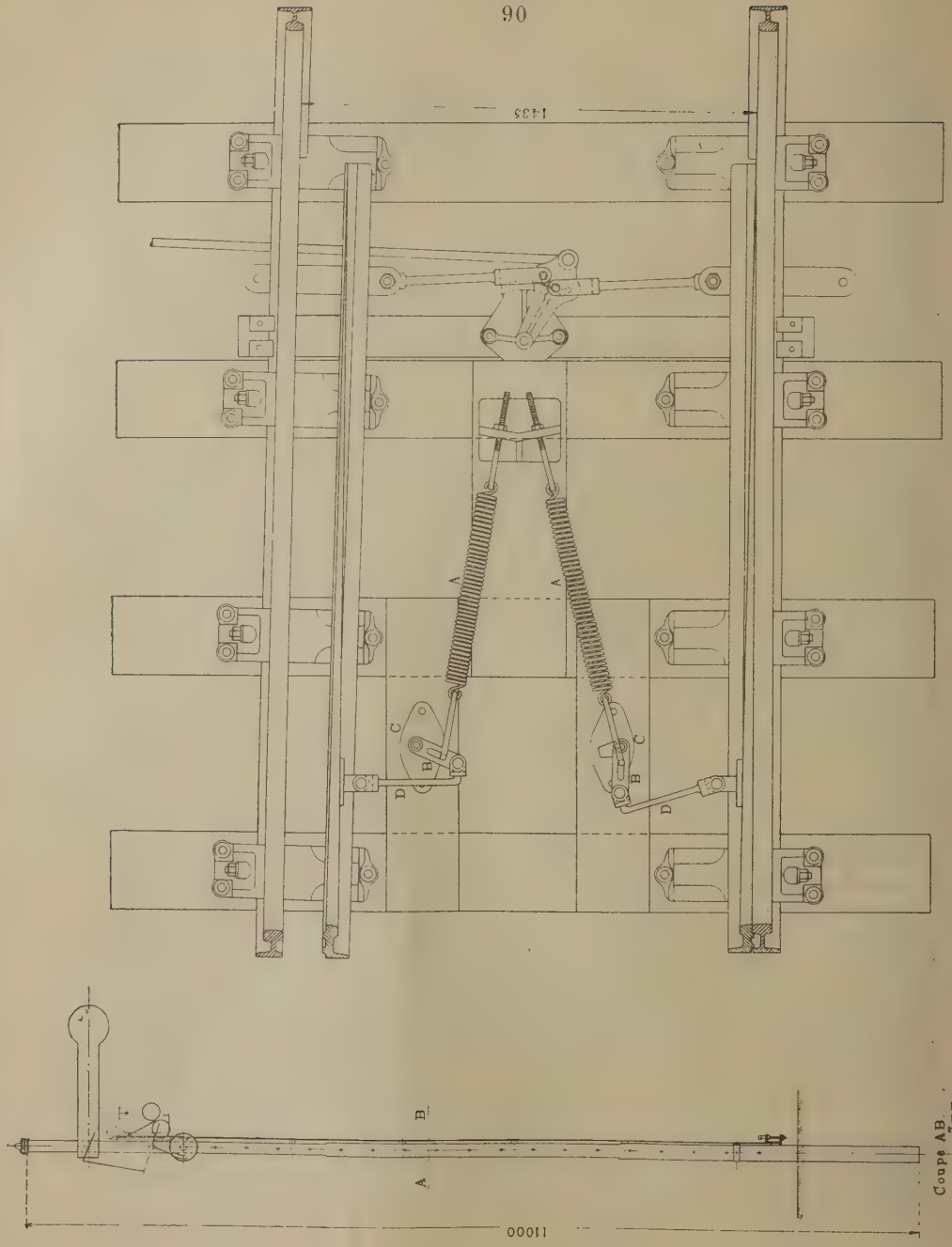

Fig. 3.

(31 ft. 2 in.) above the ground level. The arm is operated by means of a slotted lever actuated by a chain pulley; the construction of the semaphore has been described inthe *Bulletin of the International Railway Congress* (1).

The steel plates rust on the inside where the conical tubes are inserted into each other. Water of condensation deposited on the inner edges assists the corrosion.

The life of the semaphore masts does not generally exceed twenty years.

In recent years, semaphores have been adopted in which the mast consists of a Mannesmann tube, shown in figure 4; it is hoped that this will give longer life to these signals.

The greater number of the signals are lighted by means of paraffin lamps; during the last few years, the nickel reflectors of these lamps have been replaced by glass lenses giving better concentration to the light with reduction in the first cost and in maintenance. In stations fitted with electric light, incandescent lamps (of 10 candle power and with a lens, have been in use for upwards of ten years for the station signals; the paraffin lamps have, however, been retained for the home and distant signals.

Normal incandescent 10 candle power lamps have been used successfully: they are placed in parallel across the main cables laid for the purpose. The use of electricity has effected a considerable saving both in respect to the staff required for lighting up and in maintenance.

The semaphore signals of the H. R. are nearly the same in construction as the signals of the N. S. R. A difference exists in that one of the coloured glasses is placed in a hole cut out of the arm and that the other is carried in a frame connected to the angle iron edges of the arm. The movable platform for the lamp carries a shutter which cuts off the light of the lantern until it has been elevated to the correct height.

f) Transmission gear.

In the article in the *Bulletin* just quoted, we have described the wire-transmission in which a steel wire 5 millimetres (0·197 inch) in diameter is used for operating the points and of 4 millimetres (0·157 inch) in diameter for operating the signals; No. 11 of the *Bulletin* for 1908 contains a description of transmission by wires laid in tubes filled with oil; this method is frequently adopted on the N. S. R. for crossing under canals and under the sleepers of the tracks.

The transmission gear is not fitted with arrangements for locking the apparatus operating the points in case of the breakage of the wire.

Being of good material, the galvanised steel wires only break when they have become reduced in size by oxidisation; they should then be renewed.

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(1) Vide *Bulletin of the Railway Congress*, No. 10, October, 1903, p. 1105.

The use of safety apparatus to act in case of fracture of the wire is not required by breaking of the wire itself, but by the fracture of the joints and through the serving giving way.

When the joints are well soldered and varnished, when welded chains are used on the pulleys instead of served wire, and when the gear is efficiently maintained, it has not been found necessary to use such apparatus which complicates the installation.

In the case of the distant signals, the slot lever gear is so arranged that the arm goes to danger in case of rupture of the wire; the working of this gear, however, is not positive, particularly when a transmission gear of some length is altered frequently after it has been installed.

g) Compensating gear.

Compensating gear for maintaining a uniform tension in the wires is only used when the length of the transmission exceeds 900 metres (984 yards) and it is situated on a curve.

The N. S. R. in such cases uses the "Marissen" oscillating compensator described in appendix IV.

No compensating gear is used in the transmission to points, even though these be situated at a distance of 550 metres (600 yards). In the case of facing points distant more than 250 metres (273 yards) from the cabin, bolt-locks are fitted. The N. S R. also uses bolts for main line points when the distance is shorter and when there is no difficulty in fitting them.

h) Bolt-locks for points (detectors).

On the N.S.R. in general only one, two or three bolt-locks on the straight are fitted to a signal wire. Only very rarely is a wire deviated from its direct line for the purpose of fitting a bolt. In such cases, if the points are of such importance as to require a bolt-lock, it is preferred to operate this by a special lever.

The detector-bolts shown in figures 5, 6 and 7, consist of a bar T-iron inserted in the transmission to the signal; this T-bar is guided between plates, slides in cast-iron guide-blocks and locks the bars, A and A', connected to the points. When the signal is at " line clear " the T-bar does not hold the bars, A and A', and consequently the points. The object of the bolts is only to verify the position of the points; as the points should be capable of being taken from the trailing side when wrongly set, the construction enables the signal to be reset to danger because the notched blade of the T-bar can be displaceda bove the bars A and A'. This displacement is possible because the guide-plate B can lift with the T-bar against the tension of the springs by which it is held to the cast iron guide block.

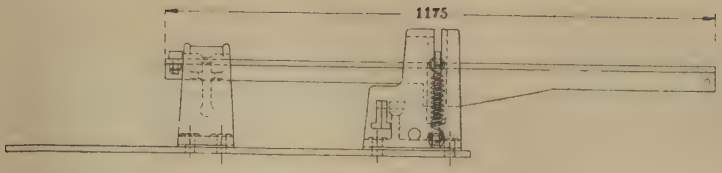


Fig. 5.

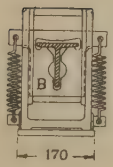


Fig. 7.

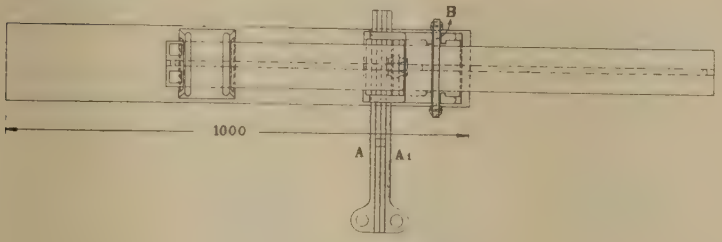


Fig. 6.

The H. R. applies bolts of the construction shown in figures 8 and 9, giving a slight resistance to movement; it does not appear necessary to describe these bolts.

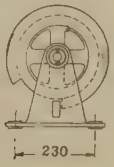


Fig. 8.

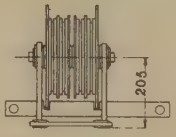


Fig. 9.

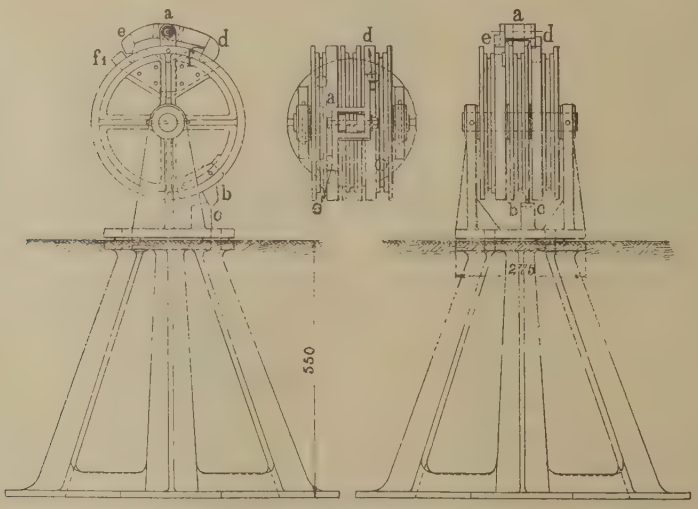
Bolts which allow the points to be taken trailing when wrongly set are generally made for insertion in the distant signal transmission and are connected to the outermost points at small stations where they are operated from alongside the station buildings. When there is no starting signal, it is possible for the train to be started without putting the distant signal to danger. In this case, a bolt which did not permit running through trailing would suffer damage, and it is almost certain that the operation of the distant signal having been rendered impossible, the arm will stand at " line clear ". The train following may, therefore, find the points wrongly set and the signal corresponding to the correct road standing at " line clear ". With a bolt arranged for running through trailing, the signal can always be put to danger, whereas the bolt bars prevent the signal being pulled off, since they never return to their original position after the points have been taken trailing.

i) Slotted gear.

Slot gear inserted in the wire transmission is used as shown in figures 10, 11 and 12, with the object of making the position of a signal simultaneously dependent on two cabins. These appliances consist of a system of three pulleys all turning on the same shaft.

The two outer pulleys are connected to the two hand-levers, whereas the centre pulley is connected to the signal. This latter pulley carries a movable shaft of special form fitted on each side with a ratchet-lever; one of these ratchets slides on the edge of the right-hand pulley or enters into the notch in it, whereas the other ratchet occupies similar positions in respect to the left-hand pulley.

Fig. 10. Fig. 11. Plan. Fig. 12.



Figs. 10 to 12.

When the levers are in their normal position, the stop *b*, fixed to the centre pulley, meets the finger *c*, on the pulley frame, while the ratchets are opposite the notches in the pulley or partially entered therein.

In operating the left-hand pulley the corresponding ratchet *d*, which is of wedge shape, is raised; this ratchet, sliding on the rim of the pulley, engages the ratchet *e* with the right-hand pulley. It thus locks the right-hand pulley to the centre pulley.

In operating the first pulley, nothing is done except to place the ratchets in position so that, on operating the second pulley, the centre pulley connected to the signal is rotated.

In setting one of the outer pulleys to its normal position, the middle pulley connected to the signal is always driven by means of the tappets f and f', which engage the ratchets in this direction of rotation.

The slot mechanism is sometimes constructed of other form : When fitted on the semaphore masts, the centre pulley may be replaced by a simple crank arm connected direct to the semaphore arm.

j) The use of insulated rail sections on the H. R.

In many stations, the H. R. uses electric apparatus consisting of track circuits to prevent the authorisation of the arrival of a train on a road already occupied. Appendix V gives a description of the working of these appliances.

CHAPTER II.

The use of water, compressed air and electricity for transmission.

The railway companies in the Netherlands have, during the last few years, followed the example set by neighbouring countries, and have put some centralised frames at work in which the work of the signalman is assisted by supply of power. The advantages of these installations have been often described; it appears to us unnecessary to enumerate them here.

Trials have only been made in the Netherlands on a very small scale because the question only arises in the case of new installations. In existing installations, a change of system is not under consideration.

The zone of the cabins is already very large, thanks to the use of the double-wire transmission. By this means, the operation of the points and signals can be effected at a great distance, without expenditure of much force, and the radius of action approaches that which can be obtained in practice by means of power distribution.

It should be noted, moreover, that the radius of action does not depend exclusively on the method of transmission, but account must be taken of the situation and of the position of the points, the requirements of the traffic, etc.

One hesitates to employ complicated mechanism in the signalling department for fear of difficulties in the maintenance of the appliances.

Urgent need for making important modifications in the systems in use, which do not merely diminish the hard work of the staff, occurs only when great importance is attached to the permanent control of the appliances, which control is only obtainable by the new systems.

*

Although the importance of this control cannot be questioned, it is doubtful whether it alone justifies the high cost of installation of the new appliances.

For railways on which the traffic is not very heavy or the work very lucrative, it is better to wait until appliances of this type become, like all other artificial mechanical aids, of more general use, of greater simplicity, and of lower cost.

In each of three large stations in which trials were made, only one cabin was fitted with a power supply system. Fortunately the two large companies chose two different systems; whereas the H. R. installed in the cabin at Haarlem station an electro-pneumatic system by the firm of Stahmer, and in one cabin the electric operation of two sets of points and five signals by apparatus coming from the " Allgemeine Electrizitäts-Gesellschaft " of Berlin, the N. S. R. has fitted to a cabin at Rosendaal Station and in the marshalling yard at Maarn, the Siemens & Halske electric system, and has fitted a signal operated by liquid carbonic acid, also made by the same firm.

We can now compare these installations under the same conditions of climate and ground and the Railway Board, who will inspect these, will be able to form an opinion on the relative value of the different systems.

a) Electro-pneumatic installation in Haarlem Station.

The installation at Haarlem Station comprises a cabin with an electro-pneumatic apparatus for operating 25 sets of points with 2 stop tappets, 1 bolt-lock and 4 signals. Appendix VI contains a description of the installation, and figure 13 shows diagramatically the arrangement of the signals.

The central frame for the electro-pneumatic operation is on the Siemens & Halske system. It is exactly similar to the central appliances of the entirely electric installations at Antwerp (see the *Bulletin of the Railway Congress*, August 1904), and of Schwerte (see June and July numbers, 1908).

The construction of apparatus for working the points and signals does not differ much from those of the appliances at Bishopsgate described in the *Bulletin* (1).

At Haarlem, the iron casting containing the slide-valve is placed in an extension of the motor cylinder and not on its side. The bolts of the slide, which are disengaged by a supplementary electro-magnet, and with which the Bishopsgate appliances are fitted, are not used in the new appliances.

The points have a flexible rail for the point-tongue which tends to spring away from the stock-rail. They are fitted with a detector or verifier of the position of the point-tongues. The air pressure on the piston is sufficient to hold the point-tongue against the stock-rail; nevertheless, the points can be taken trailing when wrongly set, without causing damage.

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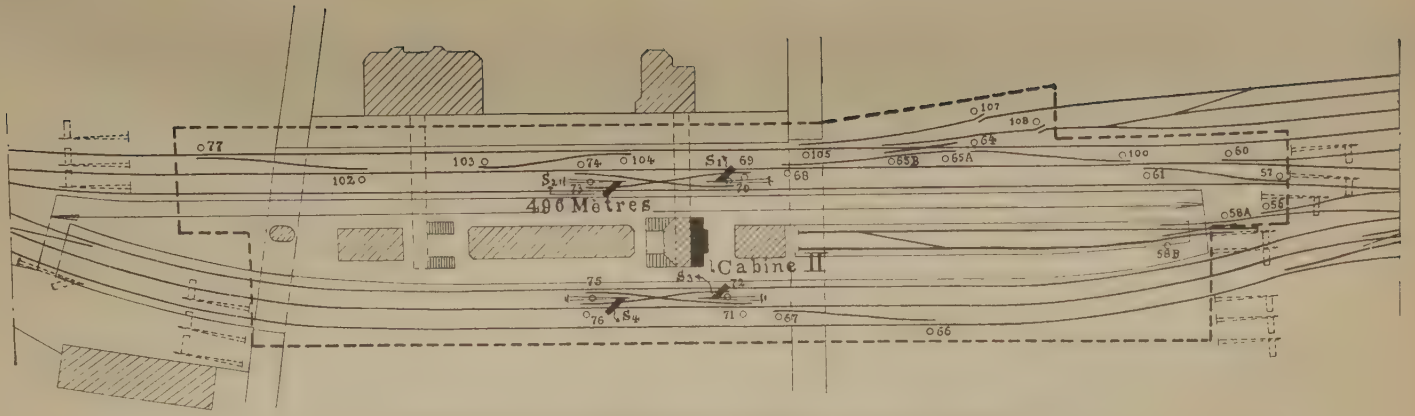
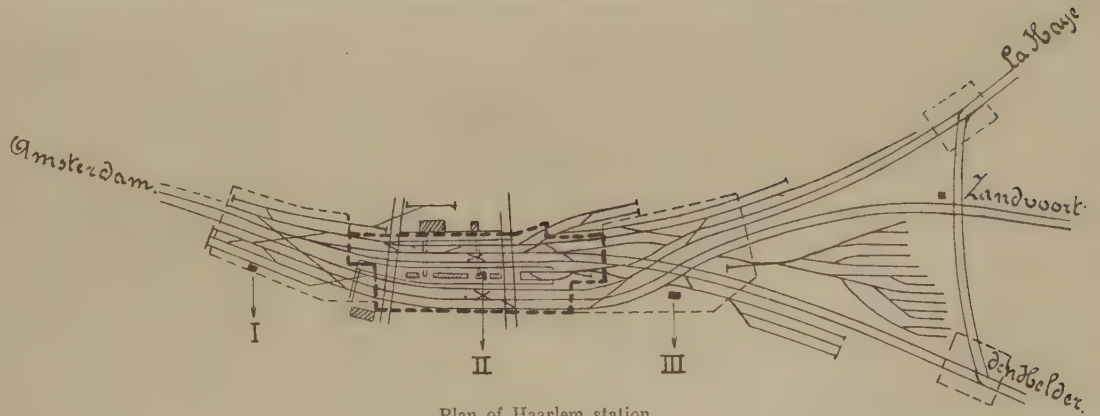
(1) Vide *Bulletin du Congrès des chemins de fer*, May, 1896.



Haarlem station. — Electro-pneumatic transmission to points and signals.



Plan of Haarlem station.

Fig. 13.

Explanation of French terms Cabine II = Cabin II. — La Haye = The Hague.

When points are taken trailing under these conditions, the fact is shown by the detector gear.

The signal arms are fitted with an indicator consisting of a cylinder with metallic segments on which brushes bear, closing or opening the indicator current of the signals.

This indicator current moves the indicators in the apparatus in the signal cabin and shows the position of the signal arm.

The insulated rail sections for preventing premature operation of the points are not fitted on the appliances at Haarlem, although there is nothing to prevent their being fitted and this could be done in the same way as in those installations which are operated electrically.

The plant for compressing and cooling the air is placed in a cellar under the station offices. It consists of a horizontal compressor driven by a 5 kilowatt electric motor by means of a belt-drive. Under normal conditions the motor uses 8 amperes at 440 volts.

The air supplied by the compressor first enters a chamber in which any moisture is deposited, and then passes into two reservoirs each 1 metre (3 ft. $3\,^3/_8$ in.) in diameter and 2 metres (6 ft. $6\,^3/_4$ in.) in height. When the pressure in the reservoirs falls as low as 4·5 atmospheres, the motor starts automatically. It stops when the pressure reaches 6 atmospheres.

The reservoirs are connected by a cooling coil to the main pipes. Experience shows that this coil can be done away with when the intake and air reservoirs are situated in a cold place; the air becomes sufficiently cooled during the period it is stored in the reservoirs. An apparatus for injecting alcohol tends to diminish freezing in the pipes during winter. In case of any defect appearing in the pump or in its motor, the Westinghouse pump on a locomotive can supply compressed air to the reservoirs. Pipes for such temporary supply are arranged in view of the possibility.

To operate the 32 sets of points and signals, about 10 to 15 kilowatt-hours are required par day. In winter the losses of air are less than in summer, because the grease in the stuffing boxes of the motor cylinder becomes thinner as the temperature rises and allows the air to escape.

The consumption of electricity for operating is found on the average to amount te 0·4 kilowatt-hour par lever per day. The indicator current is 0·1 ampere.

Electricity is supplied at 18 volts by nine accumulators, which are charged twice a week for three hours, by a motor-dynamo, giving a current of 40 to 45 amperes at 24 volts. The efficiency of the motor-dynamo being 40 per cent., the indicator current requires 15 kilowatt-hours per week, or from 2 to 3 kilowatt-hours per day.

One must therefore reckon 0·5 kilowatt-hour as the consumption for both operation and indicator per lever per day.

b) Electric operating gear of the points and signals of a junction near Haarlem.

The *Allgemeine Electrizitäts-Gesellschaft* of Berlin has fitted a trial installation for operating five signals and two sets of points at a junction near Haarlem. The apparatus for operating the signals depends upon the use of a solenoid which acts on the signal arm and on an electro-magnet which displaces a stop. This stop serves to lock the operating mechanism while the signal arm is at danger.

The solenoid and the electro-magnet are placed one above the other in a sheet-iron box of a section of 260 × 470 millimetres (10 1/4 inches × 1 ft. 6 1/2 in.), and of a height of 1,050 millimetres (3 ft. 5 3/8 in.). The solenoid has two windings, the one on the upper part and the other on the lower part; its diameter is 250 millimetres (9 13/16 inches) and its height 540 millimetres (1 ft. 9 5/16 in.). It contains a movable cylindrical core with conical ends.

When current flows through one of two windings, the core is attracted in one direction or in the other. The rod connected to the signal arm is attached to a lever, which is moved by the core. A cylinder, the piston of which is immersed in glycerine, serves as a dash-pot.

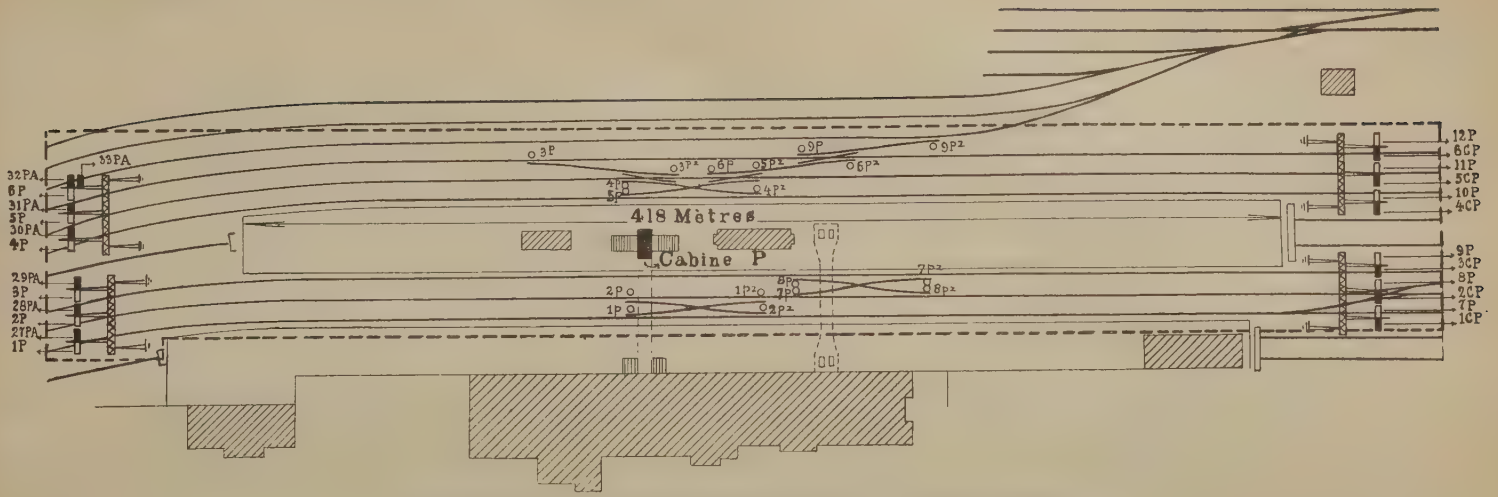
Movement of the core can only occur when the armature of the electro-magnet actuating the stop is attracted by means of the same current. The solenoid and the electro-magnet displace contacts which make the different circuits for operating the signal and the indicator.

A current of 2·6 amperes at 220 volts flowing for two seconds and a half is required to set the signal " line clear ", whereas 2 amperes is sufficient to set it to danger.

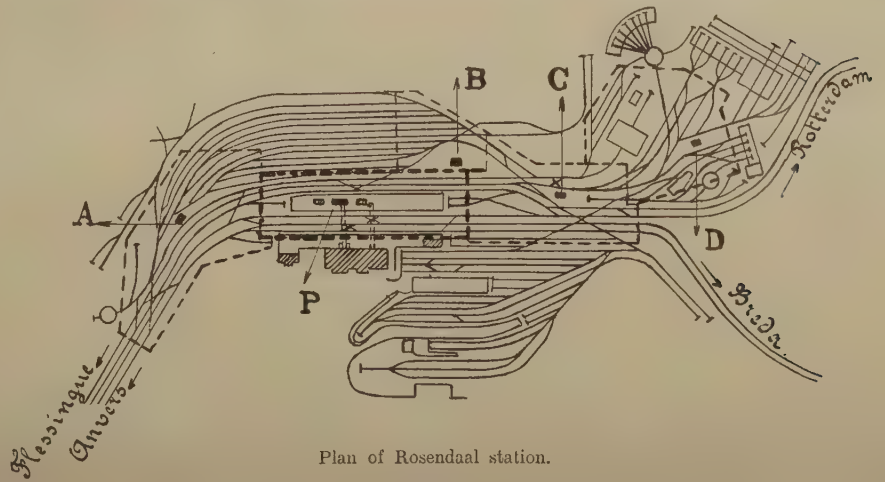
The indicator current, when the signal is set to " line clear " is 0·75 ampere a 220 volts, whereas, in the danger position it only amounts to 0·06 ampere.

In the apparatus for actuating the points, the armature of the electric motor is coupled to an endless screw which acts on a nut; this nut is connected to the point rods which it operates. Indicator contacts show the signalman the exact position occupied by the point-tongues. Untimely operation of the points is prevented electrically by the insertion of a relay to the operating circuit. In the relay circuit, there are three switches placed on the sleepers between the rails. These switches correspond to three other pieces, which are carried on three horizontal arms, fixed to three places on the arrangement of point-tongues and connecting bars.

This system consists of two rails 7 metres (23 feet) long, fished together and to the following rails in the usual manner; tho whole is only secured by screw-spikes of the track. The inside overhangs the upper surface of the sleepers about 5 millimetres (3/16 inch) owing to the action of the flat springs which are placed below the rails and tend to throw them over to the outside. When the train occupies the rails, they are pressed towards the inside ; the sole of the rail bears on the sleepers the arm placed between the rails is inclined, the contact is made, the current put to earth, the relay is attracted and it is impossible to operate the points.



Rosendaal station. — Electro-pneumatic transmission to points and signals.



Plan of Rosendaal station.

Fig. 14.

c) Electric Installation at Rosendaal.

At the Rosendaal station on the N. S. R. the installation comprises 2 central appliances for electrically operating 15 sets of points and 24 signals. The floor of the cabin is only at a height of 60 centimetres (2 feet) above the covered platform. Two appliances have been adopted which are placed opposite to the cabin, in order that the signalman operating the points can see the trains on the tracks alongside the platforms. Appendix VII gives a description of the installation, and figure 14 shows the signal arrangements diagramatically.

The central appliances in cabin P are of the latest type but one by Siemens & Halske, and analogous to those in Haarlem Station. Electric cables with 5 wires connect the central appliances to the points and to the signals. The apparatus for operating the points and signals has been described in the *Bulletin of the Railway Congress* (1). The appliances for operating the points are fixed to a frame of angle-iron, which embraces the rails at the points.

Figure 15 shows the apparatus connected to a jointed wedge arrangement constructed for running through trailing when wrongly set, made by Schnabel & Henning, such as is in use on the N. S. R.

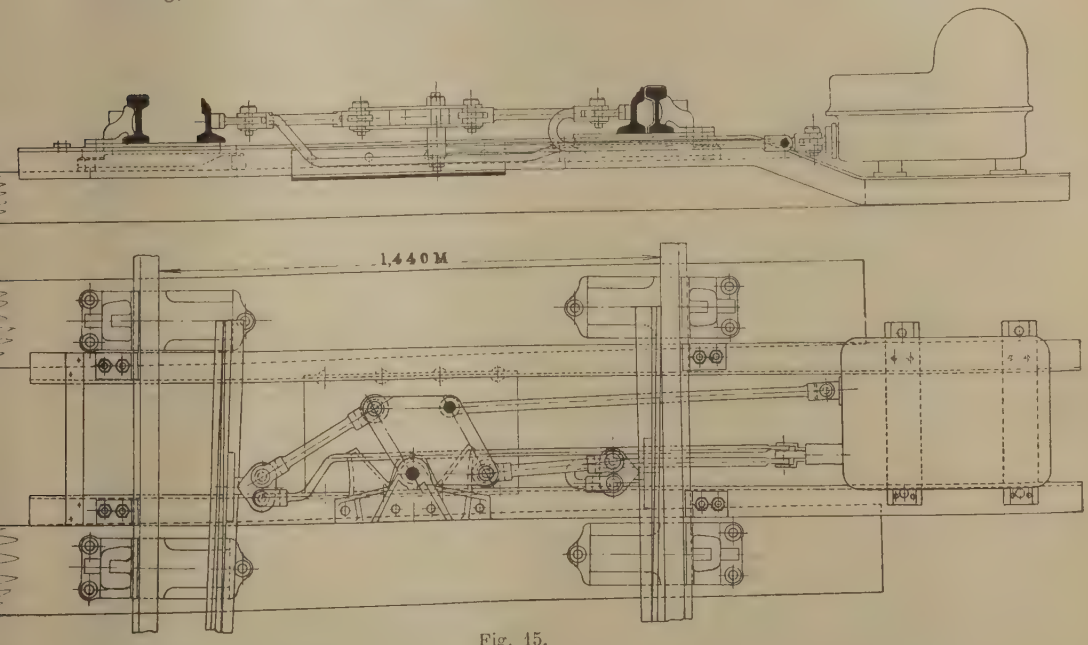


Fig. 15.

(1) Vide number of August, 1904.

Signals which are shown by two letters, for example, AP in figure 14, are actuated from the two cabins A and P. The signal has only one motor; the working and coupling circuits going from cabin P to the signal are controlled by contacts made or broken by operating the corresponding levers in cabin A on the hand-lever frame.

Signals with two arms have only one motor; a selector gear connects the motor to either of the arms.

The point-tongues on main lines are fitted with indicator contacts showing the position of the tongues.

These arrangements, as well as those for operating two sets of points with a single lever, and those for locking the points while any vehicle is on them, are installed in the same manner as in the Antwerp station.

The N. S. R. has no flexible-tongue points in use, as on the H. R. It seems that this type of point-tongues has some disadvantages when applied to normal electrically operated points. The apparatus and the motor can turn partially under the pull of the point-tongue in its sprung position.

To overcome this difficulty, the firm of Siemens & Halske, in their last catalogue, have described an apparatus with a spring wedge which engages with the connecting crossbar and prevents dangerous displacement.

On the N.S.R., at Maarn and Rosendaal, electricity is supplied by three accumulator batteries of 72 cells of a capacity of 27 ampere-hours and of 9 amperes discharge current. During the charging operation of one of the batteries of 72 cells by connecting it through a commutating resistance to the lighting circuit at 220 volts, the second battery can be used for the electric operation of the points and signals, and supplies electricity at 120 to 150 volts; the third battery, divided into four sections of 18 cells each, coupled in parallel, serves for the indicator circuits supplying current at about 30 to 40 volts.

Very simple switches are employed for charging the batteries and for using them in rotation for the operation and for the indicator circuits.

The N. S. R. have found that the consumption of energy measured at the supply circuit (before the accumulators), for operating and for the indicators of thirteen points and one signal at Maarn, is about 0·2 to 0·25 kilowatt-hour per motor per day, of which, the indicator circuit at 30 to 40 volts absorbs about 90 per cent.

The published figure for this consumption amounts at Schwerte for 127 levers and at Düsseldorf for 107 levers to 0·12 kilowatt-hour per lever.

d) Signal operated by carbonic acid.

The N.S.R. has fitted a distant signal on a swing-bridge consisting of a semaphore operated by compressed carbonic acid, of which the mechanism was supplied by Messrs. Siemens & Halske. This signal is at the same time the distant signal of a block signal situated near the bridge-keeper's cabin. The signal arm can

occupy three positions : 1°, horizontal position, showing danger, when the swing-bridge is open; 2°, a position inclined at 45° downwards, requiring slacking if the bridge is closed, and if the block signal is at danger; 3°, a position inclined at 45° upwards, giving " line clear " if the bridge is closed and if the block section is clear.

The signal arm is operated by a lever which can occupy three positions; it is fitted in a lever frame fixed on the side of the canal opposite to that on which the signal is placed. The operating lever is connected to two current switches. It cannot be moved from the danger position to the position for slacking unless the bridge is closed, and cannot be moved from this position or from the danger position to the " line clear " position unless the bridge is closed and when the lever operating the block signal is at " line clear ".

The operating current and the indicator current are supplied by a battery of six accumulators of 10 ampere-hours each, charged by 16 Meidinger cells, while an underground cable containing seven wires connects the appliances to the signal.

The carbonic acid is stored in liquid form in a reservoir at the foot of the semaphore, containing 20 kilograms (44 lb.) of acid at a pressure of 40 to 50 atmospheres; a reducing valve reduces the pressure to 2·5 atmospheres before the gas is admitted to one of the two operating appliances.

The operating appliances consist of two cylinders, each with a piston and each fitted with two valves which are operated by electro-magnets. The valves admit carbonic acid to either side of the piston. The arm is connected by a vertical rod to the centre of a movable rocking-lever. The ends of this rocking-lever are connected by rods and levers to the operating appliances.

The combination of these rocking-levers, rods, and levers is such that the displacement of one of these operating appliances from its normal position moves the signal from the danger position to that for slacking (*caution*), while the operation of the other appliance sets the signal to " line clear ". The throwing back of one of these appliances always sets the signal to danger.

To set the signal to slacking (*caution*) or to " line clear ", carbonic acid is admitted on the upper side of the corresponding piston. The admission valve is opened by sending a current round the electromagnet by pulling a lever (switch) placed in the cabin.

When the piston has reached its lowest position, the mechanism moves the contacts; the current ceases to flow round the electromagnet operating the valve, and magnetises another electro-magnet the armature of which is connected to a stop which interlocks the corresponding bar in the position it occupies at the end of its travel; the valves which have been moved put each end of the cylinder in communication with the atmosphere; the supply of carbonic acid is shut off.

On throwing over the lever, the current in the electro-magnet of the stop is cut off, and the arm falls by its own weight to danger. In case of failure, if it did not

fall in a short period of time, a mechanism which travels a certain distance in a given time, would open an electric circuit passing through the electro-magnet of the stop valve; this valve would open and carbonic acid would be admitted to the under side of the piston.

Under normal conditions, therefore, there is no consumption of gas when setting the signal arm to danger. The carbonic acid reservoir is placed on a balanced plate; when the weight of carbonic acid has diminished below a certain quantity an alarm rings in the cabin. Indicators in the signal cabin show the position occupied by the signal arm.

This apparatus has been at work for three years; its cost, including the signal, the electric cables and operating-lever amounted to 3,600 francs (£144). The carbonic acid reservoir is replaced at intervals of three weeks; the signal is operated about 50 times per day : the derangements which we have had show that such apparatus requires some care in maintenance.

e) Comparison of expenses with hand-levers and with power distribution.

It is interesting to compare the first cost, the cost of operating, and the cost of superintending the installation for the different appliances.

For large installations with hand levers (cabins containing 30 to 70 levers, interlocked with each other by electric-slots or station block-apparatus), one finds that the cost of the central apparatus in the cabins, including the slot-gear and all electric apparatus (alarms, telephones, etc.), varies from 400 to 1,000 francs (£16 to £40) per lever. The lower cost relates to apparatus which has a large number of operating-levers and a small number of route-levers and electric slot-appliances. The higher cost relates to complex apparatus.

A mean cost of 800 francs (£32) is found for 500 levers. Taking count of the fact that with a single lever one often operates two sets of points or two signals, and that 1,000 levers are connected to about 1,300 points and signals, the cost of the central apparatus, per set of points or per signal, becomes reduced to 620 francs (£24.16*s*.)

The cost of installation of the operating apparatus for the points, including some bars, some bolts and some ground signals at points, amounts to 550 francs (£22) per lever, or to 350 francs (£14) per set of points.

In the case of signals, an average of 450 francs (£18) must be reckoned per signal; this average covers the simple disks and also the level crossings with signals which frequently require to be fitted.

The wire transmissions, which are laid at large stations in sheet iron culverts, are found to cost 500 francs (£20) per lever, and 350 francs (£14) per set of points or per signal. The sum of these figures shows that for a complete installation

1,800 francs (£72) per lever, or 1,370 francs (£54.16*s.*) per set of points or per signal, must be allowed.

In installations of normal size on the N. S. R., 1,300 track appliances can be subdivided into 835 sets of point apparatus and 465 signal appliances; it is necessary, therefore, in preparing a preliminary estimate of the cost of a signalling system to allow 2,150 francs (£86) for each set of points. These prices do not include the cost of the cabins; this must be reckoned at from 150 to 400 francs (£6 to £16) per lever according to the type of foundation, the architectural work, etc.

The electro-pneumatic installation at Haarlem cost for 30 sets of points and signals, 84,000 francs (£3,360), or 2,800 francs (£112) per set of points or per signal. The cost of the installation of the motor-compressor, the accumulator, etc., amounting to 20,000 francs (£800) is not included in this sum.

The estimate for a similar installation at Amsterdam for 120 sets of points and signals amounts to 208,000 francs (£8,320), that is to say, to 1,720 francs (£68.16*s.*) per set of points or per signal, exclusive of motive power, accumulators for the indicators and the cabin building. It is to be noted that in the installation under consideration, the H. R. uses a number of small shunting signals, costing only 50 francs (£2) each, which reduces the total by 50 francs (£2) per set of points or per signal.

The price of 1,700 to 1,800 francs (£68 to £72) per set of points or per signal includes 460 francs (£18.8*s.*) for the central apparatus in the cabin and the electric appliances, 410 francs (£16.8*s.*) for electric cables and conduits, 900 francs (£36) for the operating gear for a set of points and those of signals and their accessories.

The compressing plant and its accessories, including the accumulators, cost 20,000 francs (£800) at Haarlem and will cost 33,500 francs (£1,340) at Amsterdam.

For the electrically-operated appliances at Rosendaal and at Maarn, we have found that 2,200 francs (£88) per set of points or per signal must be reckoned.

The central apparatus in the cabin costs about 400 to 500 francs (£16 to £20) per set of points or per signal.

The operating gear for a set of points consists of the point operating gear and a locking device which permits running through trailing when wrongly set; including the expenditure on installing, these have cost, on the N. S. R., 1,100 francs (£44).

The present price quoted by Messrs. Siemens & Halske of 685 francs (£27.8*s.*) (exclusive of 50 francs [£2] for fitting expenses, adjustments and making connections to the electric cables) per set of point-operating gear and of 806·25 francs (£32.5*s.*) (exclusive of 55 francs [£2.4*s.*] for fitting expenses) per signal-operating gear. These prices include free delivery in Holland, but do not include the supply or fitting of detectors to the point-tongues, the foundation frames, or the rodding connecting

the point-tongues with the operating rack, nor do they include the cost of designing the installation for a large station (1).

At Rosendaal and Maarn, the electric cables cost about 500 francs (£20) per set of points or per signal.

The cost of the power supply installations varies greatly according to whether the batteries can be charged direct, or whether special charging plant must be provided. In the small installations at Maarn and Rosendaal the cost was only about 7,500 francs (£300).

It follows from the above details, that in the case of large installations operated by manual labour alone from 1,100 to 1,600 francs (£44 to £64) per set of points or per signal must be allowed; in the case of the electro-pneumatic installations of the firm of Stahmer, 1,700 to 2,800 francs (£68 to £112) per set of points or per signal and 20,000 to 33,000 francs (£800 to £1,320) for the power station; in the case of the entirely electric system of the firm of Siemens & Halske from 1,500 to 3,000 francs (£60 to £120) per set of points or per signal and from 7,500 to 20,000 francs (£300 to £800) for the power station.

SECTION *B*.

Arrangements adopted to ensure that the position of point-tongues taken facing or trailing cannot be altered prematurely or before the train has completely cleared.

The search for an *efficient* arrangement for preventing premature shifting of the points forms one of the most difficult problems to be solved for ensuring safety in railway working.

A mechanical solution becomes more and more difficult in its application because the distance between the axles of carriages is being continually increased; a lock-

(1) The cost of a point-operating gear can be detailed approximately as follows:

1° Apparatus for operating points, capable of being run through trailing, contained in a cast-iron casing, delivered free in Holland	685·00	francs	(£27. 8*s*.).
2° Laying down, adjustment and connections to the cable	50·00	—	(£2).
3° Foundation frame	32·50	—	(£1. 6*s*.).
4° Rodding connecting the point-tongues to the operating-rack	23·75	—	(19*s*.).
5° Detectors for the position of points-tongues	78·75	—	(£3. 3*s*.).
6° Fitting items 3 to 5	31·25	—	(£1. 5*s*.).
7° Cost of preparing designs for a complete scheme for a large station	18·75	—	(15*s*.).
Total	920·00	francs	(£36.16*s*.).

ing-bar or a treadle, formerly of sufficient length, is now too short to prevent the untimely operation of a lever.

Moreover, the points in large stations are more and more entangled, and the appliances necessary to protect against false settings of a set of points then require to be arranged in the crossings or in the preceding set of points.

In the application of the solution of the problem by employing electricity, based on the use of insulated lengths of rail, a new source of trouble is introduced and only the first difficulty is removed; the second remains unaffected.

In the case of a large scissors-crossing at a station with a number of slip-points succeeding each other and extending over from four to eight tracks, it is almost impossible to find a mechanical arrangement which will be efficient and will not get out of order in a short time.

The application of an insulated rail to each of the slip-points on a large scissors-crossing is difficult; it is generally only fitted at the ends of the route taken by trains passing from one track to another.

But if this is done, shunting operations are hindered when they are performed according to signals, or else untimely shifting of the points during shunting of trains is not prevented in the case when signals are being used. Such may occur the more often since the operations have to be performed more quickly when shunting trains than is the case with the ordinary service. Many of the derailments which take place during shunting operations, and of which the causes are not ascertained at the enquiry, may be attributed to untimely shifting of the points which can very easily occur owing to the closeness together of the levers which operate the points.

It should, moreover, be noted that in cases where shunting operations are performed without signals, derailing occurs through throwing over points, not fitted with a treadle (locking-bar) either mechanically or electrically operated, to rectify a wrong setting while the train is approaching.

The mechanical appliances for locking the points (while occupied by vehicles) by means of a bar arranged in advance of the point-tongues, and of a length equal to the maximum distance between the centres of consecutive wheels, may be divided into two categories : 1° those which are operated by the train wheels (treadles); 2° those which are operated by a rocking-lever either connected to the point-operating gear, or which are operated separately.

We can state, without hesitation, that appliances of the first category, constructed to suit different methods of application, have not given satisfactory results.

Their great length involves a very rigid form of construction in order that the depression caused by the first wheel may be transmitted as far as to the point-tongue.

This heavy form of construction requires a rather strong spring to lift the appliance; it follows that the shocks to which the apparatus is subjected by each train are so violent that they speedily cause wear in the appliance and necessitate its renewal after a few month's work. These appliances are damaged when the points are

run through trailing while wrongly set, unless apparatus of complex construction is inserted for this purpose in the transmission rodding.

Appliances of the second category are in use extensively on the railways of the Netherlands.

The N. S. R. has for many years employed treadles, connected to the shunting appliances, of a length of 7 metres (23 feet), and with five points of attachment spaced 1·20 metres (3 ft. 11 $^1/_4$ in.) apart at the ends and 2 metres (6 ft. 6 $^3/_4$ in.) at the centre, and having one end overhanging to the extent of 0·60 metre (1 ft. 11 $^5/_8$ in.) (appendix VIII).

To ensure that it is in proper working order, the treadle is tested every second month by pulling it over against a stop which is fixed to the rails and takes the place of the train wheels.

It is impossible to fix the treadles on the inside of the track at slip-points because of the check-rails which are placed in advance. In such cases, outside treadles are fitted, as shown in figures 16 and 17, which require no explanation.

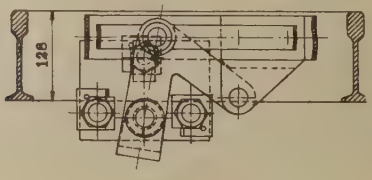


Fig. 16.

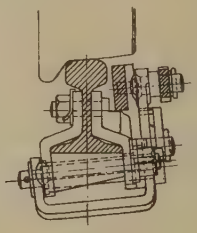


Fig. 17.

The treadles referred to in appendix VIII have the disadvantage that the points of attachment must correspond to the spacing of the sleepers. It is often difficult to find a suitable place for these attachements between the sleepers.

In 1908 we fitted treadles, on the outside of the track, 11 metres (36 feet) in length, the points of attachment of which were carried on a supplementary rail or channel-iron carried on the sleepers.

These treadles and their attachements, carried on the auxiliary rails, are not subjected to the forces which act on the track rails.

The H. R. has treadles in use which differ but little from those employed on the N. S. R. (see figs. 18 and 19).

The N. S. R. considers that a treadle 7 metres (23 feet) in length is sufficient even for a longer distance between consecutive wheel centres. It is satisfied that after one moving wheel has left the treadle, its upward moment is directly prevented by the approach of the succeeding wheel,

Recently some treadles 11 metres (36 feet) long, fitted outside the track on an

auxiliary channel iron have been put to work. It is possible to avoid this extra length by adopting an improvment in the construction of the points recently devised by Mr. Boland, engineer to the N. S. R.

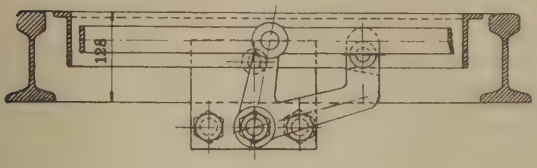


Fig. 18.

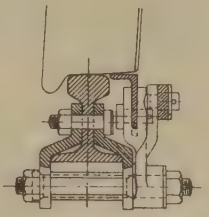


Fig. 19.

This invention consists in the use of " lifting " point-tongues instead of " sliding " point-tongues. As shown in figures 20 and 21, the end of the point-tongues is fitted with a shaft which moves in a hole in a small vertical lever, having its fulcrum on another shaft fixed to the point-chair.

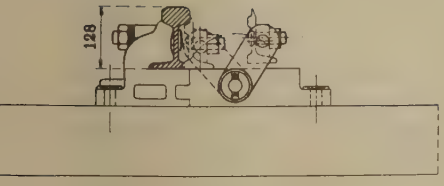


Fig. 20.

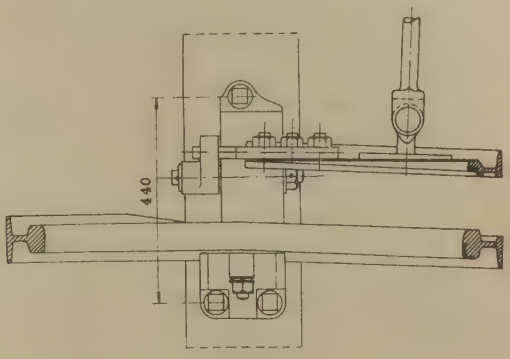


Fig. 21.

In its normal position the point-tongue rests on the chair; on throwing it over it lifts above the rail because its point is forced te follow the curve described by the extremity of the short lever. During the latter portion of its travel, the point falls again because the lever passes its vertical position. On again setting the point to normal position, it falls against the rail, so that it is certain to occupy its proper position.

Thus one portion of the point-tongue serves as a treadle, because it is impossible to lift it when it is occupied by a wheel.

The portion of the point-tongue near the heel does not act as a treadle, because it

is possible to depress it a few millimetres by the application of a force equal to that produced by the operating mechanism.

By combining this construction of point-tongues with treadles 7 metres (23 feet) in length, the arrangement for preventing premature shifting of the points is lengthened so as to attain 11 metres (36 feet) in length, which appears sufficient at the present time.

At the commencement of this report, we drew attention to the fact that it is difficult to connect treadles to all the points which form the large scissors-crossing for a number of tracks at the entrance to a large station.

Such a system already comprises a very complex system of mechanical construction. The numerous fastenings and the large quantity of moving pieces subjected to successive blows by the trains, require careful maintenance. This maintenance should not be hindered by the presence of parts of numerous apparatus which are not an absolute necessity.

But if treadles are abolished, it is necessary to have recourse to other arrangements for preventing premature shifting of the points, particularly under passenger trains. The most simple arrangement consists in the interlocking of the point-levers in the cabins in such manner that it is impossible to operate them before the train, for which the signals have been set to " line clear ", has reached a certain place.

When the home signal at the cabin A cannot be pulled off without the intervention of the block-apparatus in the cabin B, the following combination is all that is necessary; after the signal has been again set to danger, the points on the route from cabin A remain locked until cabin B has unlocked them, and B does not do this until the moment when the train passes his cabin.

The N. S. R. utilises this combination in many of its stations. The disadvantages attendant are known : in the case of derailment, it is impossible to assign the blame, because it cannot be proved that B has not unlocked A too early; and in the case when B is late, the shunting operations are hindered. For the departure signals this combination cannot generally be used, but it can be seen that the consequences of an accident to a train leaving the station are less serious than to one entering the station, because the question of speed is of less importance.

It is in those stations in which the service is crowded, that the disadvantages of the system are the greatest. For this reason the N. S. R. has fitted in the past few years, on some portions of its system, an arrangement for unlocking those points which form the route by making the train itself act on an electric rail-contact which may or may not be combined with an insulated length of rail (appendix IX).

CONCLUSIONS.

LITTERA A. — *Improved centralized installations for operating switches and signals. The use of water, of compressed air, of electricity, for working the transmissions Electric interlocking. Route levers.*

The safety appliances in the Netherlands resemble in many respects the types of appliances in use in Germany and in Austria. The semaphore with arms takes the place of the disk signal used in those countries in the case of the distant signal.

For operating the points and the signals, double steel wire transmission has been exclusively in use for the last 30 years. These transmissions, which extend up to 550 metres (600 yards) for points, and up to 1,100 metres (1,200 yards) for signals, are only fitted with compensating gear under exceptional circumstances.

The distant signals are constructed in such manner as to fall to danger in case of breakage of the wire. No arrangements have been adopted for locking the points in case of breakage of the wire.

The outermost points, worked at a distance of more than 250 metres (273 yards) are bolted. One of the two companies, the company for working the Netherlands State Railways, has extended the use of bolt-locks to the greater number of the important point-tongues, where these are taken facing by express trains. Many points are fitted with operating gear permitting them to be run through trailing when wrongly set.

The safety appliances, with the exception of the interlocking of the points, consist in general in that the signals cannot be set to "line clear" except with the mutual consent of two cabins. The use of signals with superposed arms showing the route is only adopted to a limited extent on the lines of the company for working the Netherlands State Railways. The drivers find a point signal slightly raised at the outer points of small stations for giving the direction at places where trains pass without stopping.

The Holland Railway Company, by adopting candelabra semaphores in several stations, has attempted to show the drivers the route which they are to take.

The company for working the Netherlands State Railways has adopted the use of the same signals for the trains and for shunting operations inside the stations, whereas the signals of the Holland Railway Company apply only to trains in transit.

The company for working the Netherlands State Railways has adopted a system of line normally blocked on its main line, whereas the Holland Railway Company has adopted the block-system with line normally clear.

* * *

Centralised appliances for working points and signals depending on the use of

compressed air or electricity as motive power, can be applied with success to large stations. These appliances have the advantage that they require no physical effort from the staff.

The degree of safety obtained with these appliances is greater than that obtained by hand-lever gear, because it is possible to have a permanent indication in the cabin of the position of the point-tongues and of the signals.

The Stahmer electro-pneumatic appliances have not shown the disadvantages which have often been attributed to them. It must be stated that the maintenance of tightness of the piping, and that condensation from moist air have not given rise to trouble.

The electro-pneumatic appliances can be applied without the addition of special mechanism to point-tongues consisting of flexible rail, in order to permit of the points being run through trailing when wrongly set.

The cost of electro-pneumatic installations and of entirely electrical installations is, exclusive of the cost of supply of energy, higher than that of the double-wire mechanical installations, although there are cases in which the costs differ little.

The cost of the electro-pneumatic installations is, for a small number of levers, much greater than that of the entirely electric installations. For installations of small size and of great extent it is necessary to work out the cost for each particular case.

The cost can be diminished by constructing the operating mechanism for the points and signals in large quantities of the same dimensions, by means of special machinery, and in a factory equipped for this purpose, as in the case of bicycles and sewing machines. It would be well to unite the appliances for operating and those for locking the point-tongues in a single appliance which could be fixed without difficulty to all points.

It is possible that in operating signals, the solenoid has some advantages. It has to be noted that even though the efficiency of the solenoid is less than that of the rotating motor, the question of efficiency is of no great importance, because the energy required for operating is only a small portion of the total energy required including that necessary for the indicator.

Littera B. — *Arrangements adopted to prevent switches taken from the facing or the trailing side from changing their position before the whole train has passed.*

It is possible to construct mechanical treadles (locking-bars) for separate points operated by the double-wire, which, when well maintained, can give satisfaction for a distance of 7 metres (23 feet) between consecutive wheel centres. In combining these treadles with points fitted with point-tongues which lift in their to and fro movement, the distance between consecutive wheel centres may attain 11 metres (36 feet).

If the distances at which the appliances are operated are not great, mechanical treadles 11 metres (36 feet) in length, can be operated with the points. These treadles have disadvantages in case the points are taken trailing when wrongly set.

For the numerous arrangements of points which are found in a large station, the use of separate treadles is almost impossible. It is necessary to have recourse to the bolting of routes. This bolting is unlocked after the passage of the train, either by the following cabin, or by a block-apparatus at the cabin itself, which can only be unblocked on condition that the train has passed a certain place.

These combinations usually apply only to the regular trains; the shifting of a set of points under a train during shunting is not prevented.

It appears to be of importance that efficient forms of construction should be found, which may be applied to points whatever may be their situation, and which may apply to vehicles having successive axles at a great distance from each other, both for trains and for shunting operations and without causing delay where the traffic is congested.

APPENDIX I.

Description of central appliances by Messrs. Siemens & Halske for operating points and signals.

Figure 22 shows a front view and figure 23 a section of an apparatus fitted with an interlocking box containing 26 bars corresponding to 26 route-levers. Figures 24 and 25 show appliances having a greater number of bars; the supplementary boxes are fitted above the former (fig. 24), or more recently behind the appliances (fig. 25).

The two vertical supports for the apparatus are connected by two cross-frames of channel iron, R_1 and R_2, and by the interlocking box. These cross-frames carry the pedestals I, which carry the shafts for the chain pulleys and the levers H with their spring handles *h*.

The box A contains the electric slot-gears and the magnet is fitted above the interlocking box.

The interlocking between the levers is effected by a system of horizontal shafts fitted with tappets in the plane of the pulleys on the levers,and of horizontal bars, fitted with stop-pins, running in the direction of the length of the apparatus.

Vertical rods form the connection between the interlocking box and the levers. For each lever one rod corresponds to the normal position and another rod to the thrown-over position of the lever. The interlocking box is shown in figure 28, in which the combinations can be easily followed.

The rods 18 between the interlocking box and the hand-levers are guided through apertures formed in the frame of the pedestals, and are connected to the shafts by the intervention of the short levers 7.

The shafts are fitted with springs 17 or handles *k*. The spring-operated shafts correspond generally to the levers actuating the points; the spring 17 tends to lift the rod 18 and to make it leave the notch cut in the rim of the pulley.

The shafts with handles correspond to the routes; normally they are locked by means of a continuation of the handle formed as a cam *kk* (figs. 26 and 27) which engages with a notch cut in a fixed circular plate embracing the shaft and secured to the sheet iron cover.

The operate the shaft, one must press on the free end of the handle so as to disengage the cam from the notch, to the bottom of which it is pressed by a spring; at the end of its travel, the cam engages in the notch corresponding to the thrown-over position.

The shafts with handles serve to displace the interlocking bars. These bars are guided above the shafts between separating teeth in the form of a rack, spaced about

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Note. — At Arnhem station, there is an apparatus with five frames, measuring each 2,300 millimetres (7 ft. 6 $^9/_{16}$ in.), carrying 27 point-levers, (nearly all for double slip-points), 31 signal-levers, 90 route-levers, and 58 electric slot-gears.

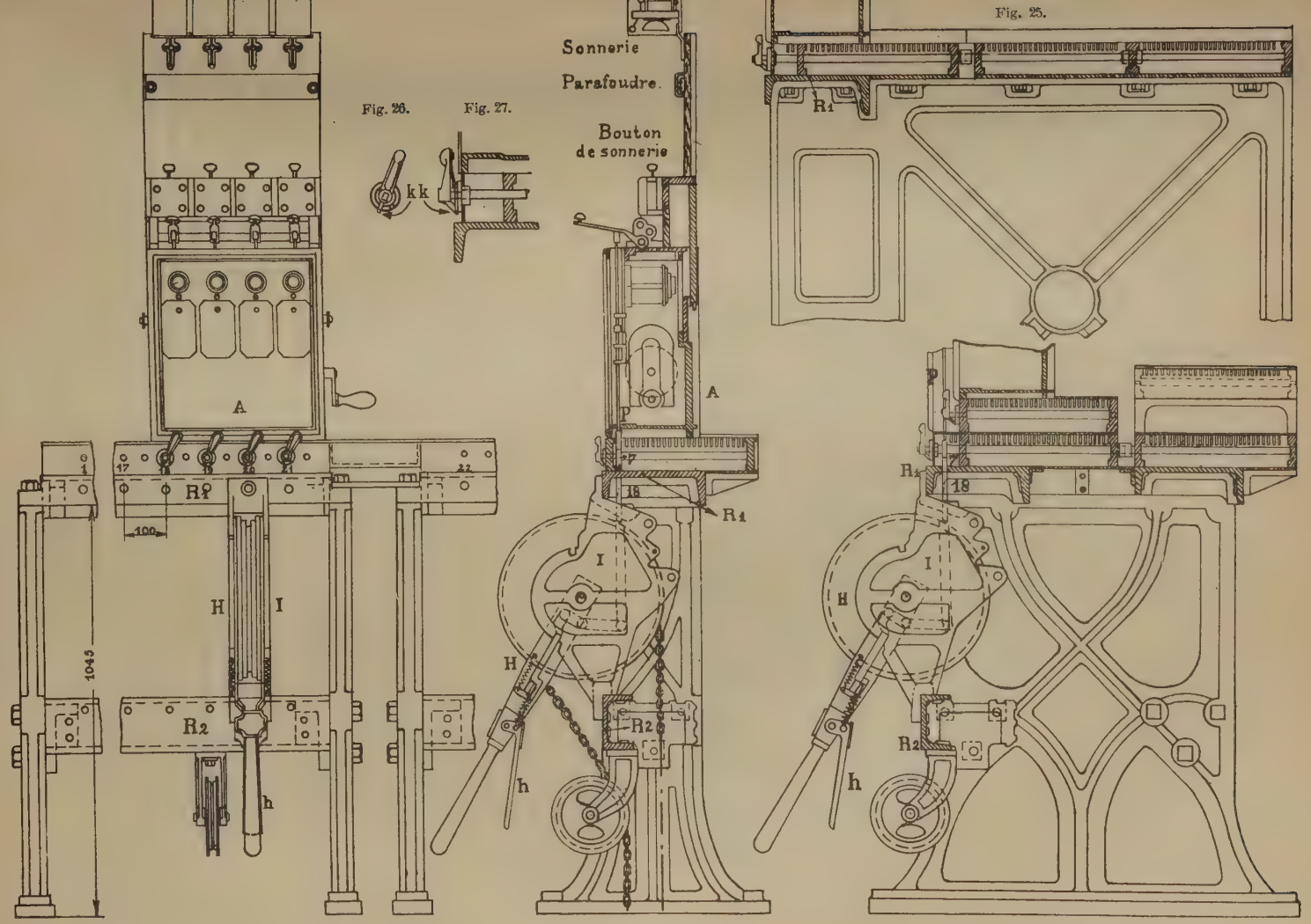


Fig. 22.

Fig. 23.

Fig. 24.

Fig. 25.

Fig. 26.

Fig. 27.

Figs. 22 to 27.

Explanation of French terms : Sonnerie = Alarm bell. — Parafoudre = Lightning arrester. — Bouton de sonnerie = Push button of alarm.

1 metre (3 ft. 3 3/8 in.). These bars lock or free the shafts corresponding to the levers interlocked.

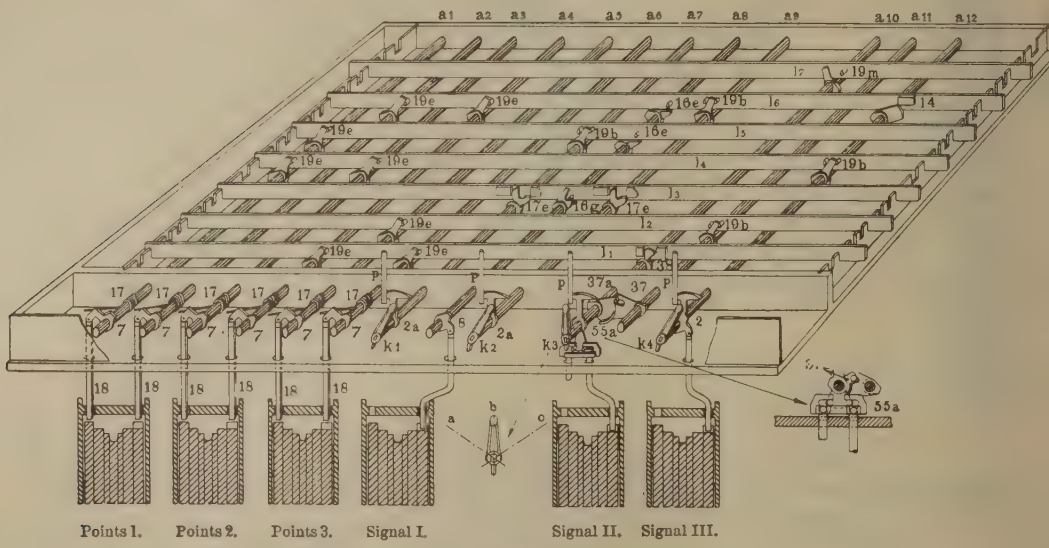


Fig. 28.

The shafts should be fitted with special cams when they are to be interlocked by the rods *p* of the electric slot-gear.

We will now examine how the interlocking is effected. The ordinary interlocking $\frac{-\text{III}}{-1\ -2}$ (the signal III is interlocked with points 1 and 2 in their thrown-over position) is effected by the route-lever *k*4, fitted on the shaft *a*12. The displacement of the handle *k*4 acts through the tappet 19*b* placed between two stop-pins, giving a to and fro movement to the bar *l*4. This bar interlocks the points 1 and 2 in their thrown-over position by means of the tappets 19*e*. The handle *k*4 frees the signal III, the interlocking with the block apparatus is obtained by the cam 2, carried on the same shaft *a*12.

Conditional interlocking such as $\frac{-\text{I}}{-1 \text{ or } +1+2}$ (signal I must be freed under two sets of circumstances; the one corresponds to the thrown-over position of points No. 1, and the other to the normal positions of the points Nos. 1 and 2) can be effected by means of two route-levers *k*1 and *k*2. In operating the handle *k*1 and the shaft *a*7, the bar l_3 is displaced by the tappet 17*e*, and the bar l_5 by the tappet 19*b*. By displacing the bar l_3 and the tappet 16*g*, the shaft *a*8 is operated, and the signal I is freed; by the displacement of the bar l_5, the shaft *a*1 is rotated and the points No. 1 are interlocked in the thrown-over position.

On operating the handle $k2$ and the shaft $a9$, the tappet $17c$ displaces the same bar 1_5, whereas the bar 1_6 is displaced by the tappet $19b$ and the points Nos. 1 and 2 are interlocked in their normal position.

After operating the signal 1, the tappets $16c$ interlock the bars 1_5 or 1_6. On displacing the bar 1_6 the tappet 14 and the shaft $a12$ are interlocked by a small plate fixed to the bar. Conversely on turning the shaft $a12$, the bar 1_6 is locked.

To economise space, handles have been made of the form known as double direction handles k^3 which can occupy three positions, a, b, c, the position b being the normal position. On operating the handle from the position b to the position a, the bar 1_4 is displaced by means of the shaft $a10$, from right to left; points Nos 2 and 3 are interlocked in the normal position and the shaft $a11$ cannot be moved.

On throwing over the handle from the position b to the position c, by special mechanism $37a$ 37, the adjacent shaft $a11$ and its corresponding bar 1_2 are displaced in the same direction from right to left, while bar 1_4 remains fixed.

By a special tappet $55a$, the rod l is lifted from the pulley of signal 11 on operating the handle from its position b to its position a, and also on operating it from the position b to the position c. The operation of the handle from right to left can only be performed when the rod P of the electric block-gear is raised.

It will be readily seen that the double-direction route-levers form an important improvement in the parts necessary for obtaining conditional interlocking.

The bars are 7 millimetres ($^9/_{32}$ inch) thick, 30 millimetres (1 $^3/_{16}$ inch) deep, and are placed 7 millimetres ($^9/_{32}$ inch) apart; all the tappets are 6 millimetres ($^1/_4$ inch) thick; their bosses which carry the screw for attaching them to the shafts, are placed below the bars. All the details of the interlocking box are of small size to which there is no objection, because it is impossible to exert a great force on the mechanism the handles being only 100 millimetres (3 $^{15}/_{16}$ inches) in length.

The distance between the electric slot gears and the levers is 100 millimetres (3 $^{15}/_{16}$ inches). The shafts are placed from 45 to 55 millimetres (1 $^3/_4$ to 2 $^3/_{16}$ inches) from each other.

The details of the point levers (figs. 29, 30 and 31) are constructed in such manner that the parts which serve for attachment to the wire by means of a chain can be disconnected from the lever when, owing to the points being taken trailing when wrongly set, a certain amount of force is applied to the wire. In the normal position, the pulley and the lever are maintained connected by means of a system of spring ratchets connected to the lever and embracing a projection on the pulley. When the force applied to the wire exceeds the tension on the spring, the pulley turns, whereas the lever remains in its place.

After the points have been run through trailing, the operation of the signals interlocked with the points, as well as the operation of the point-lever, is rendered impossible until the pulley has been restored to its original position.

If the points are taken trailing while wrongly set and while the interlocked signal is set to "line clear," the parts of the apparatus suffer no damage.

The levers with a spring-latch are constructed in such manner that the interlocking is effected by the raising of the latch before the commencement of the movement. This position does not vary during the movement of operating; the interlocking can only take place when the lever is not at the end of its travel, and when its latch is not dropped into the thrown-over position.

Fig. 30. — Section on CD.

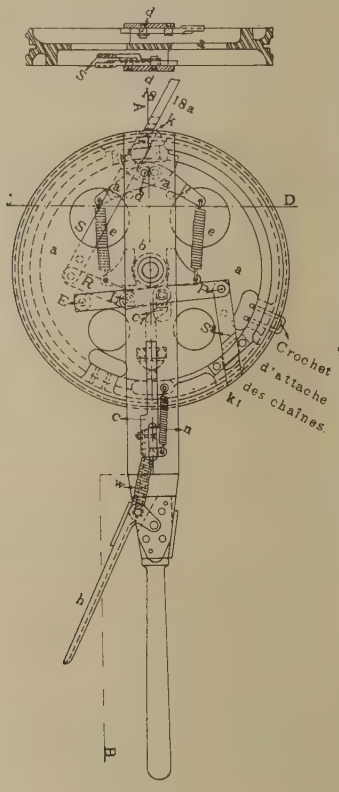


Fig. 29.

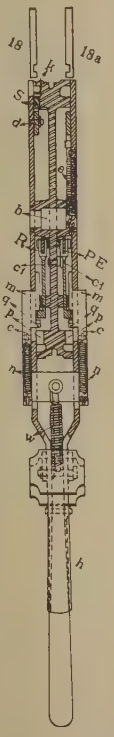


Fig. 31. — Section on AB.

Figs. 29 to 31.

Explanation of French terms : Crochet d'attache des chaines = Hook for fastening the chains.

The pulley turns about the shaft *b*. The lever is built up of two flat bars which turn freely on the boss of the pulley, one on each side; the flat bars are connected outside the pulley by a piece of steel, to which the lever is fixed.

The parts connecting the pulley to the lever consist of two spring-controlled

rocking-levers *a* pivoting on the gudgeon-pin *d* bolted to the flat bars. The rocking-levers engage the extremities of the raised rims with which the pulley is provided under the action of the springs *e* ; on the one side these cover an angle from 0 to 190°, and on the other side from 170 to 360°. The pulley and the lever are thus locked together so long as the forces which tend to disengage them do not stretch the springs to such an extent that the ratchets slip internally along the raised rims.

In the case of the points being taken trailing when wrongly set, the tension of the springs must be overcome. This tension must not be too great, otherwise the intermediate parts will be forced out of place or broken. It must be sufficient to ensure connection between the pulley and the lever if, for any reason whatever, at the end of the travel, the force acting on the wire should be increased to some extent.

To avoid the disadvantage which would arise when the tension on the springs is exceeded during the operation of setting the points, a movable piece forming one with the lever is interposed between the lever and the pulley. This interposition takes place when, by means of the handle *h* the latches *c* guided by the flat bars, are displaced against the action of the springs *n*. The latches *c* carry projections *m* and *q*.

When the latches are displaced, the projections *m* are disengaged from the notches formed in the segments on the pedestal, whereas the projections *q* engage in the notches *p* which are formed in the rims of the pulley. The projections *m*, when raised, slide over the edges of the pedestal, during the operation of the lever, in such manner as not to interfere with the connection between the lever and the pulley.

The interlocking rods 18 and 18*a* (fig. 31) are normally placed above the edges of the pulley. One of these rods 18, can be engaged with the notch *k* in the right hand edge, in the normal position of the pulley; the other 18*a* in a notch *k'* in the left edge, in its thrown-over position.

In figure 31, the point-tongues can be interlocked in the normal position. By pressing on the handle *h* to operate the lever, one acts through the pieces *c*, on two other pieces c^1. One of these pieces c^1 is connected to a lever PE turning about a shaft E, on one side of the pulley, while the other is connected to the rocking-lever R, turning about the shaft L on the opposite side.

By means of the rocking-lever R the piece S^1, guided by the edge of the pulley, is acted on, and can engage with the notch *k* below the rod 18. The movement of the lever PE is transmitted to a piece S^2, which in the thrown-over position of the lever comes below the rod 18*a* in a direction parallel to that of the piece S^1 in its normal position.

If the interlocking allows it, all the parts can be displaced, and the lever can be thrown over.

If the interlocking does not allow it, and if the rod 18 is engaged in the notch in the edge of the pulley, the operation of the lever is rendered impossible.

In this case the rocking-lever R and the piece *c* are locked; it is impossible to subject the mechanism to a force greater than that which corresponds to the stretching of the spring W inserted between the handle and the latches *c*.

After an angular movement of about 150°, the lever and the pulley come into the

thrown-over position. The latches *c*, raised during the operation, can act under the force exerted by the spring *n* owing to the fact that there is a second notch in the segment of the circle carried on the pedestal. They can move with the pieces S^1 and S^2 in the direction of the pivot; the interlocking rod 18*a* can be displaced, and the points can be interlocked in the thrown-over position.

The points can be taken trailing, when free or when interlocked with the signal. In the first case the pulley revolves, the ratchet levers shift, the pieces *c* and c^1 are disengaged, and the ratchets *a* slide along the rims of the pulley; the signalman is informed by seeing a red indicator disk and by the noise made that the points have been run through trailing.

After the points have been taken trailing, it is impossible to set the corresponding signal to "line clear", because the rods 18 and 18*a*, resting on the edges of the pulley, prevent this.

When the points are interlocked with the signal, and when they have been run through trailing, the outer edge of the pulley slides in a groove formed for this object in the rod 18, which is engaged in the notch.

In both cases the operating lever remains locked, because the projection *q* of the latches *c* is displaced in relation to its notch.

By re-setting the pulley and the points to a position corresponding to that of the lever (this being effected by means of a special lever), the connection between the lever and the pulley is established.

APPENDIX II.

Description of the central apparatus on the « Alkmaarsche Yzergietery » system for operating points and signals.

The levers of the signals and points which are fixed to the grooved pulleys can turn on the shafts A (fig. 32); these carry four levers in a group, are fastened to the cross-frames B, and are spaced 500 millimetres (1 ft. 7 $^{11}/_{16}$ in.) from centre to centre. The cross-frames are secured to each other by the rods D, which run the whole length of the lever frame; distance pieces through which the rods pass ensure the proper spacing of the cross-frames. The back part of the cross-frames is so arranged as to carry the brackets which serve as guides for the locking bars; the upper portion of the cross-frames serves to carry the block-apparatus of the Siemens & Halske pattern.

The travel of each lever is limited at each end by a movable catch *a* which engages in notches cut in the edges of the cast-iron stop plates E. The catch is operated by the catch-handle *b* pivoted to the lever C; in its travel it slides on the edge of the stop plate E which is of circular form. The stop-plates E, placed between the pulleys, are carried at one side on the shafts A and at the other side on angle-irons fitted between the cross-frames.

The levers and pulleys are of simple form, the movement of the catch-handle does not act on the parts which themselves lock or unlock the pulley.

The interlocking system consists of vertical shafts and horizontal bars; the former are fitted with tappets of the form of short levers which act on stop-pins fixed to the bars. The vertical shafts carry small lever arms on their upper ends which serve to operate them, and they carry tappets in the middle of their length which act on the horizontal locking bars. These bars enter the rims of the lever-pulleys and lock them.

The routes are arranged by the plungers F (figs. 33 and 34), the stops *c* and c^1 on which limit the travel by coming in contact with the bar *d*. To unlock a signal, the signal I for example which corresponds to the route set by the plunger F, it is necessary first to push the plunger to the left through a few millimetres against the action of a spring. The horizontal stop *c* can then pass through the hole in the plate G and it becomes possible to move the plunger outwards. This action moves the small lever on the shaft *f*1 and causes it to rotate; the shaft *f*1 carries a fork *g* at the middle of its length and this acts on the stop-pin of a bar *h*.

After this movement, the plunger is locked by moving it to the right when the stop *e* bears on the other side against the plate G.

In figure 34 displacement of the bar *h* is only possible when lever No. 4 is in its normal position and when lever No. 5 is in the thrown-over position. This displacement has the effect of disengaging the spring rod *i*, which is normally locked by

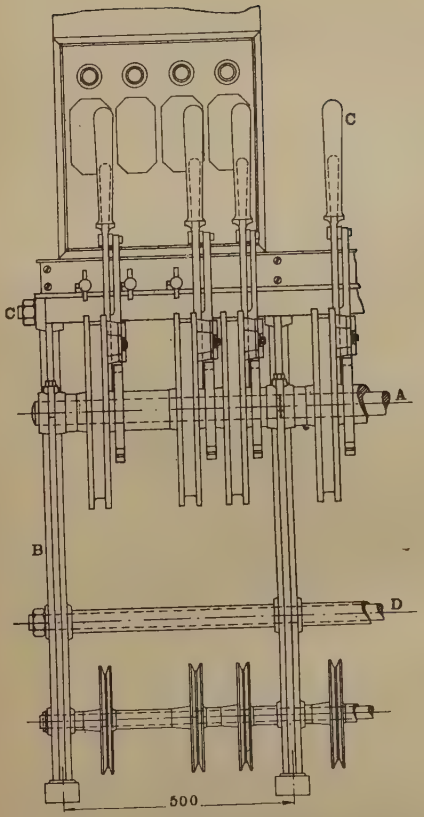
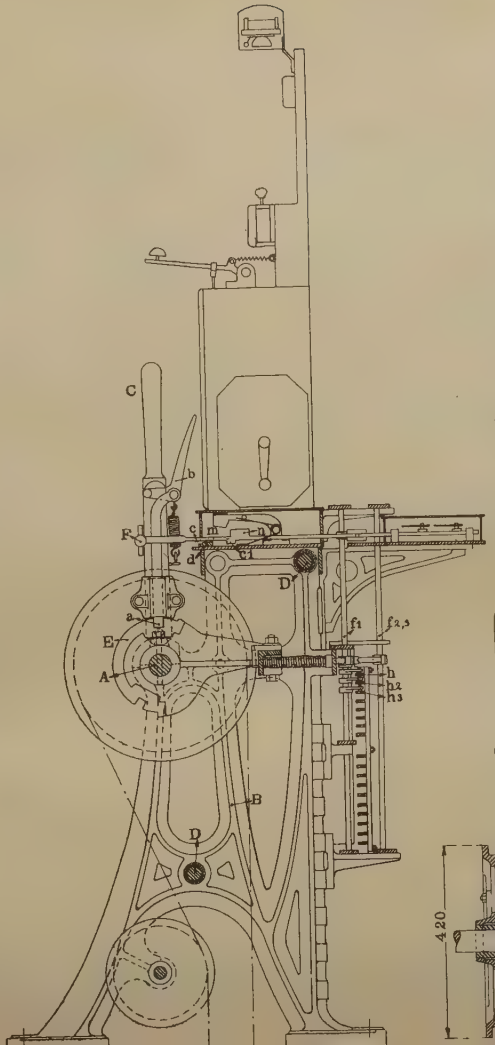
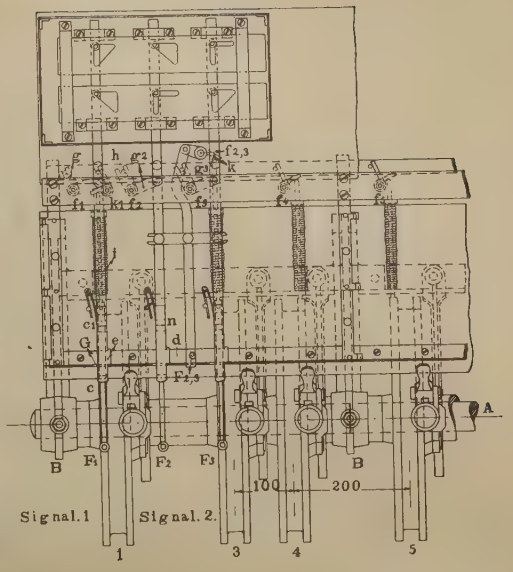

C
C
A
B
D
500

Fig. 32.

Fig. 34.


C
b
F
c
m
n
o
d
f1
D
a
E
A
f1
f2,3
h
h2
h3
B
D


f
h
f2
f2,3
k
f1
k1
f2
f3
f4
c1
n
d
G
e
F2,3
c
A
B
F1
F2
F3
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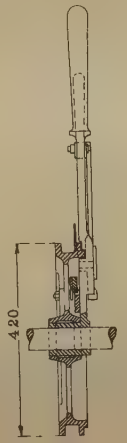
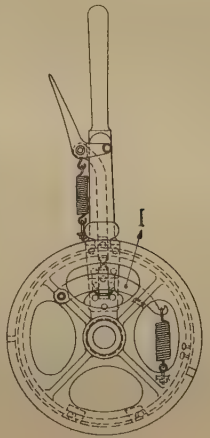
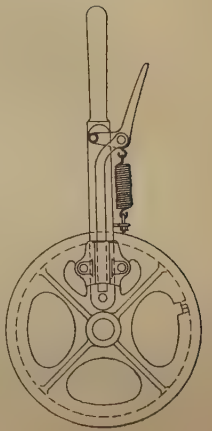
Signal. 1
Signal. 2.
1
3
4
5


420


I



the tappet *k*1. The spring-bolt *i* acts direct on the pulley of the signal I, which is consequently freed.

Conditional interlocking is obtained by inserting a rocking-lever between two plungers; a supplementary plunger is fixed to the centre of this as is shown in figure 34 for the plungers F2 and F3.

The plungers F2 and F3, by means of the small levers *g*2 and *g*3 of the shafts *f*2 and *f*3, operate the locking-bars of the points *h*2 and *h*3 (fig. 33); the supplementary rod F2, 3 rotates the shaft *f*2, 3 the tappet on which disengages pulley No. 3 of signal No II.

The ends of the block apparutus do not act direct on the plungers, they disengage or lock the ratchets *m*, lifted by a spring. The tooth on the ratchet acts on a stop *n* on the plunger.

Many of the appliances are fitted with special interlocking apparatus between the plungers which are carried in a box mounted on brackets at the back of the apparatus. The interlocking arrangements are generally provided for the purpose of disengaging a particular signal by the action of any one of several route-levers. The plungers are in such case lengthened by rods. Stop-pins are bolted to these rods, which slide in openings, either straight or inclined, recessed in thin bars. These bars are displaced by operating the plungers (fig. 34).

The levers and the pulleys shown in figures 32 and 35 cannot be run through trailing when the points are wrongly set; figures 36 and 37 show levers which satisfy this condition. In this case the pulley turns freely on the boss of the hand-lever. A spring-lever I connected to the pulley engages with a stop, the faces of which are slightly inclined where they enter the notch in the lever. In case of running through the points trailing, the tension on the spring is overcome and the pulley turns relatively to the hand-lever. On moving the lever, a stop on the catch-bolt is engaged in a notch in the inner edge of the pulley rim, and thus the engagement between the lever and the pulley is re-established.

This construction does not admit of the points being taken trailing when wrongly set in cases when the points are locked by the movement of a signal-lever.

APPENDIX III.

I. — Description of shunting appliances arranged for taking trailing on the N. S. R.

Figures 38 to 42 show the shunting appliances on the N. S. R. which are arranged for taking trailing.

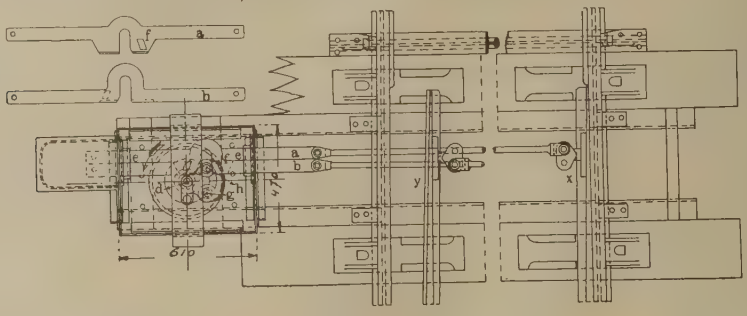


Fig. 38.

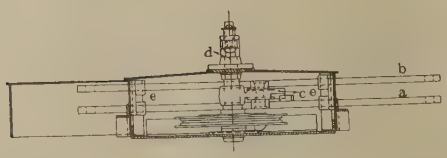


Fig. 39.

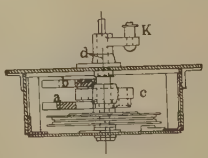


Fig. 40.

Abb. 42.

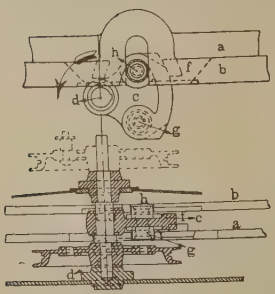


Fig. 41.

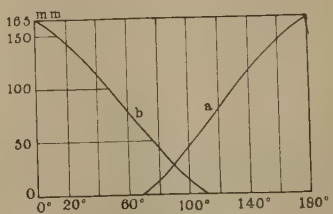


Fig. 43.

They consist of a closed box constructed of plate and angle-irons; a movable shaft *d* passes through the centre and is fitted with a pulley and chain; this is placed at the

bottom of the box where underground transmission is used and above the cover in the case of transmission above the surface.

The shaft carries a cam *c* formed as a quadrant of a circle (figs. 41 and 42) and fitted with two rollers, the one *g* below, and the other *h*, above the cam. The roller *h* engages in a groove in the plunger *b*, whereas the other roller *g* engages, after displacement of the cam, with the groove in the plunger *a*.

The plungers are guided in cast-iron blocks *e*, bolted to the walls of the box. The plunger *a* is connected to the point-tongue x, and the plunger *b* to the point-tongue y.

When the roller *g* has left the groove, the edge of the piece *c* holds the tappet *f* of the plunger *a*, in such manner that the plunger *a* and the crossbar are so held that the point-tongue x remains pressed against the stock-rail. At the same time, the plunger *b* and the corresponding point-tongue are held in place by the roller *h*. When the pulley is turned in the direction of the arrow, the point-tongue is then immediately displaced, and the movement takes place according to the curve *b* shown in figure 43. The point-tongue x remains fixed until the moment when the roller *g* engages with the groove in the plunger *a*. The point-tongue x moves as shown by the curve *a* in figure 43.

When the points are taken trailing, the point-tongue is pressed towards the rail; the plunger *b* acts on the roller *h*, which can turn with the cam *c*, because the direction of the movement of the plunger *b* and of the line *hd* are inclined to each other at an angle of about 45°.

The movement of the cam *c* is transmitted by the pulley shaft and by the wire transmission to the operating-lever.

At a certain point in its travel the roller *g* enters the groove in the plunger *a*, and carries the latter with it; the point-tongue x will be displaced through a sufficient distance at the moment when the flange of the wheel tends to press it away from the stock rail.

The shaft *d* must be fitted with a small lever *k*, acting on the rods of a locking-bar.

The appliance is mounted on two angle-irons fixed to the rails.

As it is absolutely necessary to maintain the distance between the rails constant, a crossbar, fitted with two chairs, is placed in front of the points.

In all those systems which can be taken trailing, the crossbars connecting the point-tongues together must be omitted.

The rodding connecting the operating-gear is attached to special pieces fixed to the point-tonges. Each of these pieces is fitted with two holes with steel bushes so that it is possible to connect the rodding wherever it may be required, and to change the point of attachment in case of wear.

The same appliances are used for operating the point-tongues of slip-points Usually the four point-tongues of a set of double slip-points are combined with the four opposite point-tongues of a following set of double slip-points as shown in figure 44.

Fig. 44.

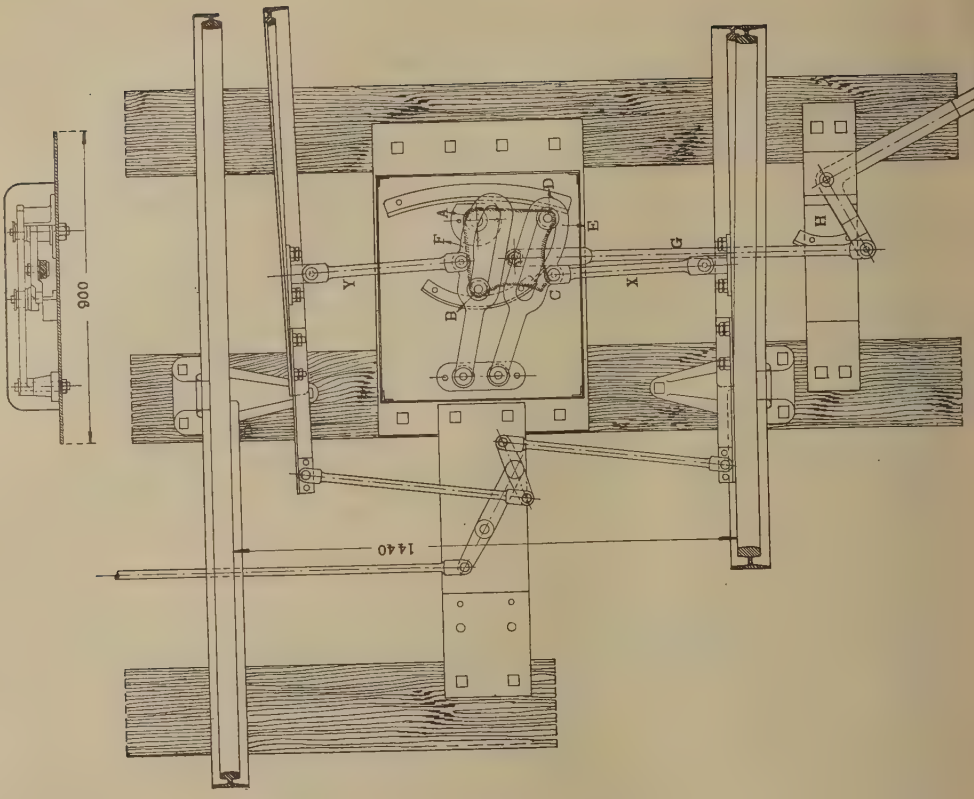


Fig. 47.

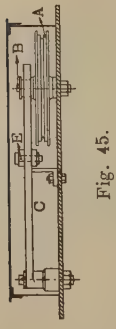


Fig. 45.

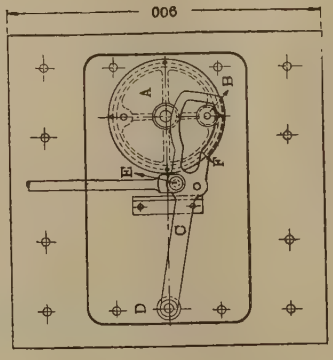


Fig. 46.

II. — Operating gear of points which cannot be taken trailing on the H. R.

The appliances for operating and locking those points which cannot be taken trailing on the H. R. (figs. 45 and 46) are very simple. They consist of a pulley A which is connected to the transmission and carries a roller B almost at its circumference. A lever C, pivoting about a pin D, is formed with an opening of special shape, in which the roller works. The lever is connected to the point-rods at E. When the pulley turns, the roller follows the interior contour of the opening as far as F, before displacing the lever. On reaching F, the roller acts on the lever and causes it to turn till it reaches the point diametrically opposite. When it reaches this point, the lever moves no further, because the roller follows the opposite circular arc, thus in about the first third of the movement, the points are unbolted; in the second third they are shifted, and in the last third they are again bolted.

The mechanism is covered with sheet-iron and fitted direct on the sleepers.

III. — Appliances which can be taken trailing on the H. R.

The appliance arranged for being taken trailing on the H. R. is shown in figures 47 and 48. The mechanism operating the point-tongues consists of a piece of cast-iron of the form ABCD, turning about a pin A and sliding at C along a curved angle-iron. This piece carries two rollers at B and D which, in a displacement through 90°, move the slotted levers E and F and at the same time shift the point-tongues by the action of the rods X and Y.

In the first third of the movement, the lever F and the point-tongue Y are shifted, while lever E and the point-tongue X are unbolted; in the second third of the movement, two point-tongues are thrown over, and in the last third of the movement, the lever F remains in position and the point-tongue Y is locked.

The movement of the piece ABCD, is effected by the rod G which is connected to the jaw of a bell-crank H, one arm of which is connected to the transmission. For this reason, the transmission should be fitted with a return pulley placed beyond the points.

When points fitted with this appliance are taken trailing by a train, the point-tongue corresponding to the rod Y is deflected; it carries with it the piece ABCD, and after moving a certain distance, this piece causes the other point-tongue and the transmission to move with it.

The points are connected to a system of rodding and levers, which operate the ground-signal of the points or the bar of the bolt-lock in such manner that it is necessary that both the point-tongues should be at the end of their travel for the signal to show the proper setting of the points or for the bolt-lock to be shifted.

For operating slip-points the H. R. uses the same appliances as the N. S. R.

APPENDIX IV.

Description of the Marissen compensating gear.

Figures 49 to 51 show the arrangement of the Marissen compensating gear. The working of this appliance is very simple.

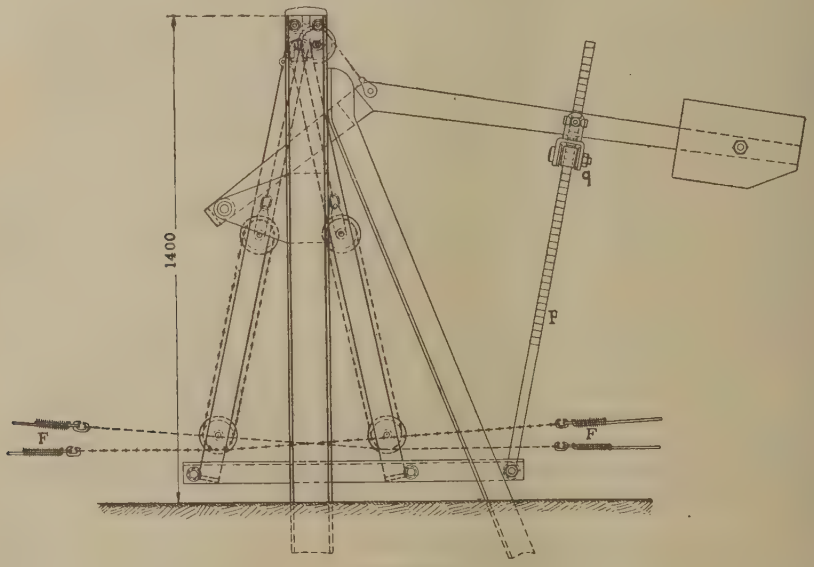


Fig. 49.

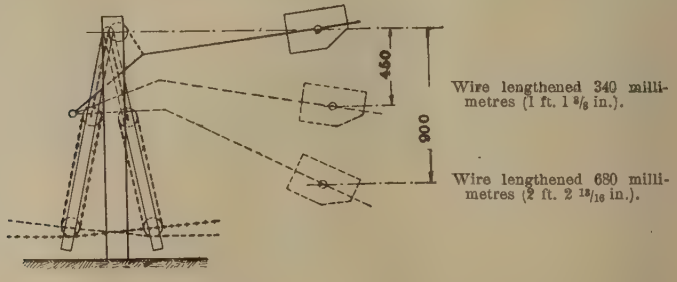


Fig. 50.

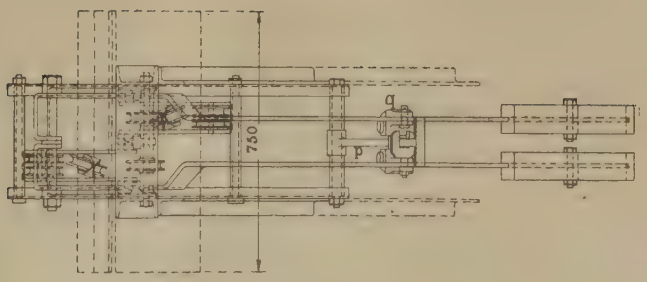


Fig. 51.

When the wire lengthens by expansion due to rise of temperature, the compensating weights fall, and the distance between the pulleys which are guided in the swing-levers increases.

When the wire shortens, the weights are lifted, and the distance between the pulleys is diminished. When operating, the swing-levers swing in opposite directions while the portion of the transmission between the swing-levers keeps the same length and the compensating weights remain in place.

A system of tappets q, connected to the levers of the compensating weights, engages with the teeth of a movable bar p and prevents too much stretching of the wire in the event of any unforeseen load coming on the transmission.

The oscillating movement of the apparatus requires scarcely any force to be supplied by the signalman. In ordinary appliances, where the transmission runs over many pulleys, a considerable force is required in performing the operation of the appliances.

The compensating weights are fitted in such manner as to give the wires a tension of 70 kilograms (154 lb.).

APPENDIX V.

Description of locking bars worked from track circuits.

Figure 52 shows in diagrammatical form an installation of two tracks at a station on a single-track line; it only shows the station block apparatus connected by means of four electric wires to the two cabins I and II placed at the ends of the station. One of the electric slot-gears A, of the Siemens & Halske pattern, relate to the direction P, whereas the other slot-gear B corresponds to the direction Q. In the case of cabin I the train can take either of the two routes on arrival, from P on to track 1 and from P on to track 2, and it can take two routes on departure, the one from 1 to P and the other from 2 to P. One only of these four routes can be used at a time. It is therefore sufficient to have an electric slot-gear in the station, which can be connected alternately to one of the four wires which are connected in the outer cabin to one of the four electric slot-gears. These slot-gears interlock or free the home signals on track 1 or on track 2 or the starting signal on one or other of these two tracks. The route, that is to say, the corresponding electric wire, is chosen by operating one of the plungers *a* and *b* or *c* and *d*, in one direction or the other, and by thus closing, for example by means of the plunger *a*, the contacts 1-2 and 3-4, or the contacts 2-5 and 3-6. The plungers are interlocked with each other, by means of bars, as show in figure 34. The interrelation between the unlocking of the arrival road and the occupation of this road is obtained by track relays placed above the block apparatus; the relay *1* relates to track 1, and relay *2* to track 2.

The relay windings are connected on the one side to a battery and on the other side to the insulated wire 1*r* of the insulated track No. 1, and by the insulated wire 2*r* to the insulated track No. 2.

In operating the electric gear A to unlock the home signal at cabin I, the contact 8-7 is closed so that the pulley P of the battery is connected by means of the insulated wire 3*r* with the non-insulated rails and to earth.

If the track is occupied by a vehicle which forms an electric connection between the two rails forming the track, the battery circuit is closed by the 4 ohm resistance of the relay electro-magnet. The relay armature is attracted and opens the contact 11-12 for track 1 and the contact 9-10 for track 2.

These contacts being interrupted, it is impossible to set the corresponding signals to "line clear". When these contacts are made, if the rod *p* of the slot-gear A is pressed down, and if the plunger *a* is displaced in the direction of the arrow, a current can be sent by operating the magneto of the block-apparatus I. This alternating current from the brush *i* can pass through the contact 9-10, the contact 4-3, and thence to contact 13.

The current passes thence through the electro-magnet of the slot-gear A to the contacf 2-1 of the plunger, and passes through insulated wire 2 to cabin I.

After the electric slot-gear A has been blocked, the plunger *a* is locked in the

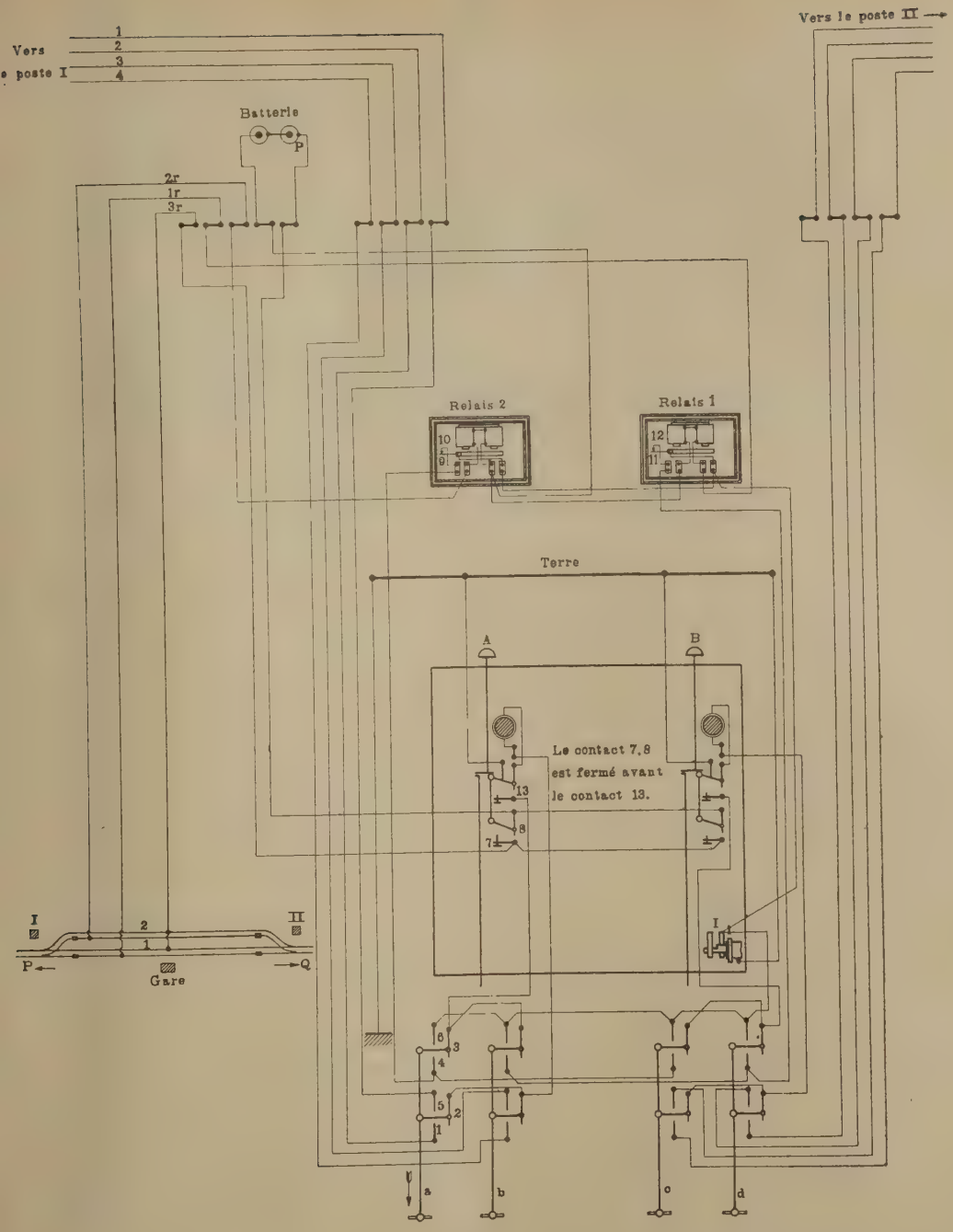


Fig. 52.

Explanation of French terms : Gare = Station. — Batterie = Battery. — Relais = Relay. — Terre = Earth.
Le contact 7.8 est fermé avant le contact 13 = The contact 7.8 is closed before the contact 13. — Vers le poste I = To cabin I.

thrown-over position; it is maintained in this position until the unlocking current is sent from cabin I. The circuit of this current is independent of contact 9-10. Contact 7-8 is only closed when the push-button of the slot-gear is pressed home: a vehicle occupying the insulated track section consequently has no influence on the relay. It follows that after performing the operation for admitting a vehicle to the track, the armature of the relay cannot remain held against the core of the electro-magnet owing to bad insulation of the track.

The insulated rail section only extends over that portion of the track, on which passenger trains are usually stopped. Its length is only from 200 to 250 metres (219 to 273 yards); the insulation is maintained between 20 and 200 ohms; this length appears to us very short.

Formerly the H. R. employed 6 Meidinger cells as the battery, arranged in groups, 2 in series and 3 in parallel; in practice the contacts 7-8 are inserted and two Leclanché cells appear to be sufficient.

APPENDIX VI.

Description of appliances for operating points and signals by means of compressed air at Haarlem station (H. R.).

The installation (fig. 13) comprises a cabin with electro-pneumatic operating appliances for 25 sets of points, 2 stop-tappets, 1 point-lock and 4 signals.

Compressed air is used as the motive power, and the action of this force is regulated from the apparatus in the cabin, which is so arranged that the points and signals are moved when electric current is transmitted.

A compressed air main pipe, which does not run into the cabin, is laid along the track and is fitted with branches leading to each set of points and each signal.

The operating gear for each set of points comprises a cylinder fitted with a piston operated by compressed air.

The piston is connected — by means of a rocking-lever for reducing its stroke — with the rodding connected to the point-tongues. Compressed air is admitted to one end or the other according to the position of a piston valve. When compressed air is admitted to one end of the cylinder, the air which is contained in the other end, can escape. The slide-valve is also moved by compressed air, and the admission of the air to both ends of the cylinder in which the piston-valve works is regulated by poppet-valves which are connected to the armatures of two electro-magnets.

The operating-gear for each signal consists of a cylinder in which moves a piston connected to the signal arm. The apparatus is so arranged that the electric current passing round the electro-magnet opens an admission valve and closes the exhaust valve; this allows compressed air to enter the cylinder and thus operates the signal arm. When the circuit is broken, the small poppet-valves are placed in the reversed position and the air is allowed to escape. The counter-balance weight then drives back the piston and with it the signal to the normal position.

The construction of the central apparatus in the cabin is very nearly the same as in the last pattern made by Messrs. Siemens & Halske shown in figure 53. We say "very nearly", because the appliances installed at Haarlem as well as those at Rosendaal, are of an earlier type, in which the controlling electro-magnets, the shafts carrying the contacts of the batteries, and the shafts carrying the contacts for coupling the signals, are installed below instead of above the hand-lever shafts.

We will first examine the diagrammatic arrangement of a set of apparatus for operating one set of gear (fig. 54) which differ only in detail from those in use for the routes and for the signals. The ordinary levers of the lever frames are replaced by shafts of special section (fig. 1).

These shafts are rotated by means of a push-key, either through 90° from the normal position to the thrown-over position in the case of points and of ordinary signals, and from 90° to the right to 90° to the left for two routes and the corresponding signal.

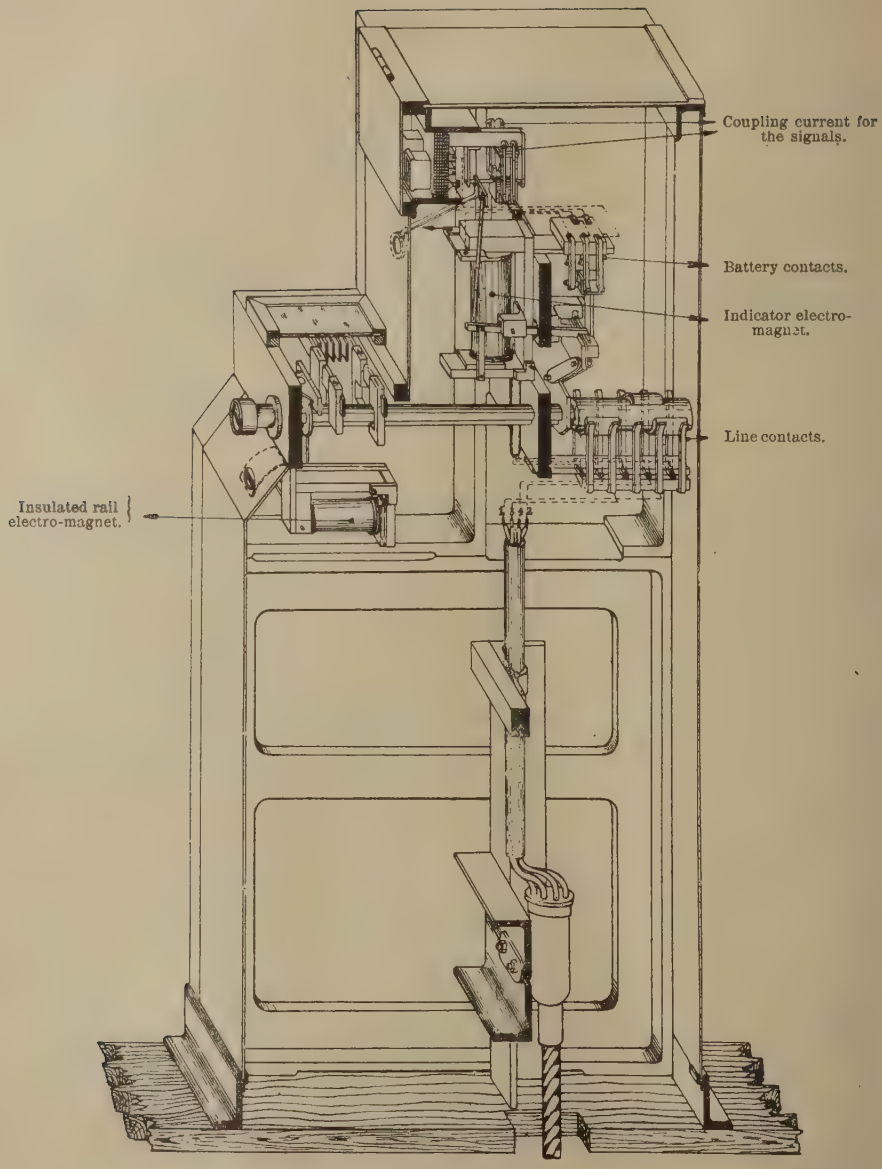

Coupling current for the signals.
Battery contacts.
Indicator electro-magnet.
Line contacts.
Insulated rail electro-magnet.

Fig. 53.

Fig. 54a.

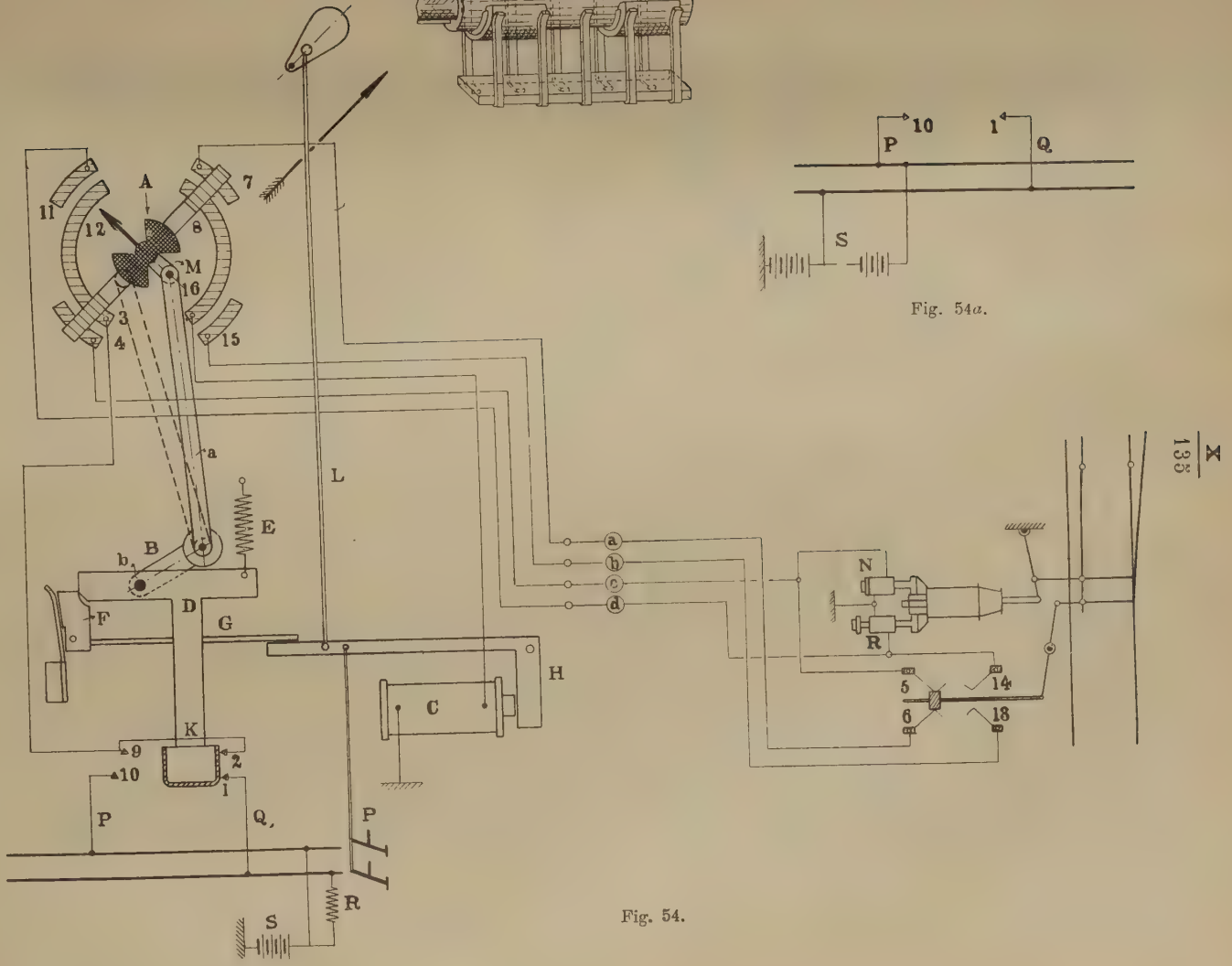


Fig. 54.

The shafts A (fig. 54) are fitted in the front part with tappets, which interlock with the locking bars, as shown in figure 1, and the back part with bronze segments which can make contact between copper fingers (the contacts are constructed like the brushes of a cylindrical commutator, as shown in the sketch placed alongside the figure). The contacts are arranged for : 1° directing the operating currents, and 2° conducting the indicator currents which circulate after the operation has been completed.

While the button is turned, a crank arm M, fixed to the shaft A is lowered, and then raised by the intervention of the rod *a* and the lever B turning about the fixed shaft *b*.

While the lever B is lowered, the piece D, turning about the same shaft *b*, and acted upon by the spiral spring E is displaced. The mechanical armature F of the piece D is disengaged, the stem G withdraws the armature H from the indicator electro-magnet C. The piece D is fitted with a prolongation K, which in one position connects the contacts 1 and 2, and in the other the contacts 9 and 10. The rod L of the drop-disk in the indicator apparatus is attached to the armature G of the electro-magnet C.

When the lever B is in its lowest position, the different parts occupy the positions shown in figure 55; the position they take after the push-key and its shaft have been pushed home is shown in figure 56.

After the points have been operated, the indicator current at a tension of 100 volts excites the electro-magnet C; the armature H is attracted; the mechanical armature F is lifted; the piece D resumes its normal position under the action of the spring F (fig. 54), while the crank-arm M and the rod *a* remain in the position shown by the dotted line in figure 54, and that shown in figure 56, and the voltage of the current flowing to the electric-magnet C is reduced to 20 volts.

Let us now examine the diagram of the circuits.

Normally the current supplied by accumulators S and through the resistance R, passes through the contacts 1, 2, 3, 4, and the wire *c* to the electro-magnet N of the point-tongue. A shunt circuit passes through the contacts 5-6 of a bar connected to the point-tongues by a wire *a* to the contacts 7 and 8 of the operating gear, and thence by electro-magnet of the indicator C to earth. The electro-magnet of the point-tongue N holds a valve in such position that compressed air is admitted to a piston valve, the ports in which correspond to the normal position of the motor piston operating the point-tongue. Contacts 5 and 6 give the indicator the position corresponding to that of the point-tongue when home; when the contact is broken, the indicator current passing through the electro-magnet C is cut off, and this is made apparent in the cabin apparatus.

On displacing the push-key and the shaft A, the contacts 1-2, 3-4 and 7-8 are opened, while the contacts 9-10, 11-12 and 15-16 are closed. The current ceases to flow through the wire *c*, while the current from the accumulators S flows through the wire *d*, without going through the resistance. The electro-magnet N is no longer excited, whereas the admission valve, acted upon by a spring, moves in such manner that compressed air is no longer admitted to the piston-valve cylinder.

At the same time, the electro-magnet R of the point-operating gear is excited by the

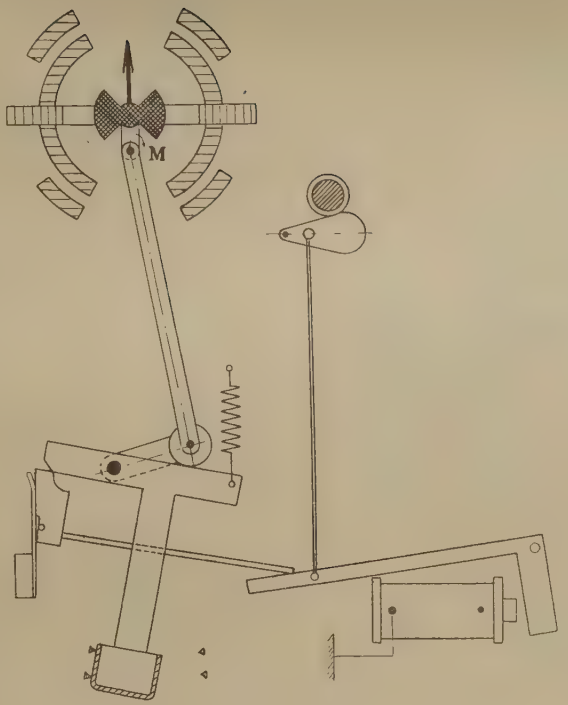


Fig. 55.

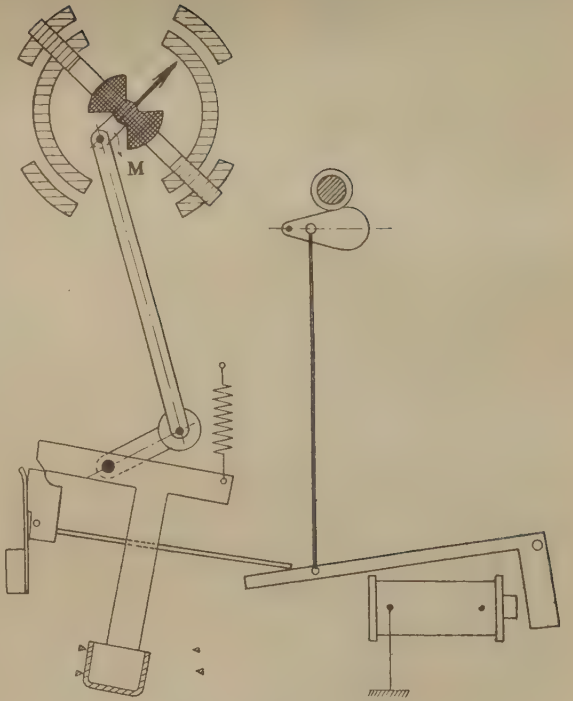


Fig. 56.

current flowing in the wire *d* and goes to earth at the apparatus. The electro-magnet operates the valves, the piston-valve is displaced until its ports correspond to the thrown-over position of the piston actuating the point-tongue.

At the end of the travel of the point-tongue the contacts 13 and 14 are closed; a shunt circuit is formed through these contacts, the wire *b*, the contacts 15 and 16, the electro-magnet C, and the indicator apparatus again indicates that the point-tongue is in its home position against the stock-rail.

The armature of the electro-magnet of the indicator actuates the contact rod P. These contacts can be inserted in a circuit (known as the coupling-circuit) which excites a coupling electro-magnet, the armature of which must be attracted before it is possible to press the push-key of the corresponding signal.

APPENDIX VII.

Description of the apparatus mentioned in appendix VI (for operating appliances by compressed air), for electric operation of points and signals at Rosendaal station.

The apparatus described in appendix VI serving for electro-pneumatic operation at Haarlem station is of the same construction as that employed for the electric operation at Rosendaal.

Figure 54, together with figures 54*a* and 57, 58 and 59, shows the installation diagrammatically.

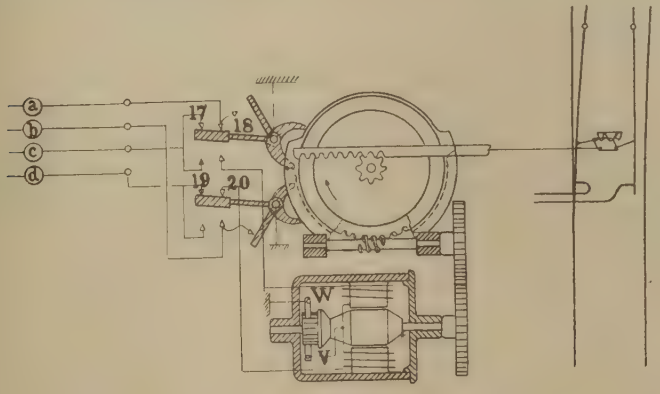


Fig. 57.

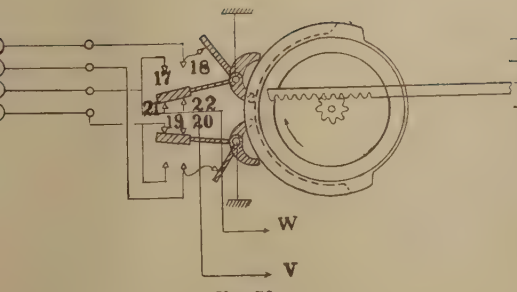


Fig. 58.

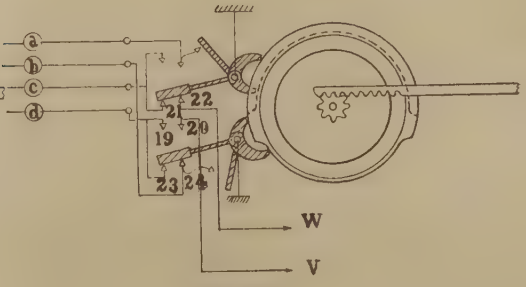


Fig. 59.

Under normal conditions the indicator current, supplied by some accumulator batteries S at 20 volts (fig. 54*a*), passes through the wire Q (fig. 54) the contacts 1-2, 3-4 to the wire *c* (figs. 54 and 57). The indicator contact 17-18 (fig. 57) of the operating-gear of the points being closed, the current passes through the wire *a* to the contact 7-8 and thence through the indicator electro-magnet C to earth. When the contact 17-18 on the operating-gear is open, the indicator current ceases to flow, and this is revealed in the operating-gear by the indicator electro-magnet.

On moving the push-key and shaft A, the contacts 1-2, 3-4 and 7-8 are opened, while the contacts 9-10, 11-12 and 15-16 are closed.

The current in the wire *b* ceases to flow, whereas the current from all the accumulators, passing through the wire P flows through 9-10 and 11-12 to the wire *d*.

This current passes through the 19-20 and the winding V of the electro-magnets, and through the armature of the motor to earth. When the motor has made a few turns (fig. 58) the contact 17-18 are broken, and the line *a* put to earth. The wire *c* is connected to earth by the contacts 21-22 and the winding W of the motor. This arrangement serves to put the motor in communication with the two wires *c* and *d*, so that the points are forced to follow all the movements forward or backward of the operating push-key.

At the end of its travel, the different contact-pieces are displaced and appear as shown in figure 59. The contact 19-20 is broken, whereas the contact 23-24 is made. The current coming from the line *d* is no longer supplied to the motor, but flows through the wire *b*, the contacts 15-16 and the indicator electro-magnet C.

The armature H is attracted, the piece K comes from the position shown in figure 56 to the position shown in figure 54; the contact 9-10 is broken, and the contact 1-2 is made, so that the working current which was flowing through the indicator electro-magnet is replaced by the indicator current at 20 volts.

APPENDIX VIII.

Description of mechanical treadles in use on the N. S. R.

The treadle attachments are constructed as shown in figures 60 and 61 when placed inside the track, and as shown in figures 16 and 17 when placed outside the track.

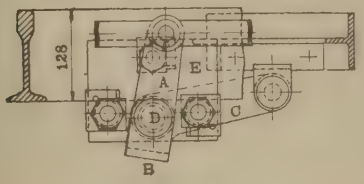


Fig. 60.

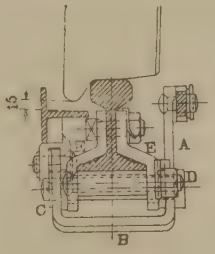


Fig. 61.

The attachment shown in figures 60 and 61 consist of a double lever ABC of curved form, formed of a flat bar and arranged partly below the rail and partly alongside the rail. This lever turns about a pin D, fixed to the plate E secured to the rail. The portions A of the levers are connected by a flat iron bar, which forms the transmission through all the attaching levers of the treadle to the operating gear. The portions C carry the T-bar forming the treadle by means of forked pieces.

The portion C of the lever is in a position considerably removed from the vertical line when the treadle is in its highest position. The wheel can touch the treadle when raised, without injuring it; the wheel then causes the treadle to be depressed.

This action is transmitted to the operating-gear so that the point-tongue is held tightly against the rail. The weight of the treadles tends also to hold the point-tongues against the rails; those points which are fitted with these treadles therefore can scarcely ever remain half-set.

The lifting of the treadle in relation to the movement of the point-tongue is shown diagrammatically in figure 62.

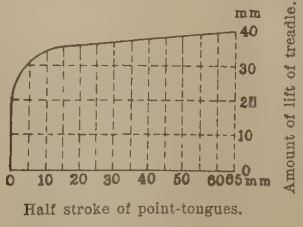


Fig. 62.

The total elevation of the treadle is 40 millimetres (1 $^{9}/_{16}$ inches); at the moment when the bolted point-tongue is going to be displaced the treadle is raised 20 millimetres ($^{15}/_{16}$ inch); when the space between the rail and the point-tongue has opened to 10 millimetres ($^{3}/_{8}$ inch), the elevation of the treadle is increased to 35 millimetres (1 $^{3}/_{8}$ inches).

As shown in figure 61, the flange of the wheel thus prevents rising of the treadle after it has lifted 15 millimetres ($^{5}/_{8}$ inch) but as it is only after 20 millimetres ($^{13}/_{16}$ inch) of movement that the points begin to move, the danger of premature operation of the point-tongues is prevented.

In the preceding, it is assumed that the travel communicated to the levers ABC is equal to that of the operating-gear of the points themselves, even in the case of the furthest apparatus; but according to our own experience this degree of perfection cannot be relied on.

A wheel placed at that extremity of the treadle furthest from the point-tongue, prevents its being operated, if the sinking, the stretching, and the shifting, under heavy loads, are not too great in relation to the travel of the operating mechanism. If this is not the case, the operation of the treadle while under the wheel of a vehicle becomes possible. When the travel and consequently the lift is great, the operation of the treadle is more effective; a large lift demands considerable force for operating, consequently we are compelled to limit ourselves to the lift of 40 millimetres (1 $^{9}/_{16}$ inches).

APPENDIX IX.

Description of an electric treadle apparatus at the termination of a route for trains departing from a passenger station.

The lever L of the block signal covering the succeeding section, which is locked by the electric slot-gear A (fig. 63) in relation with the succeeding cabin, is further interlocked with a supplementary electric slot-gear B. This latter slot-gear works in relation with a slot-gear C, locking the route. The interlocking of the slot-gear C with the route is such that it can be blocked independently of the locking of the points by the intervention of the route-lever *c*, but once this lever has been thrown over, the points, after the signal has been returned to danger, remain locked until the slot-gear C is unblocked.

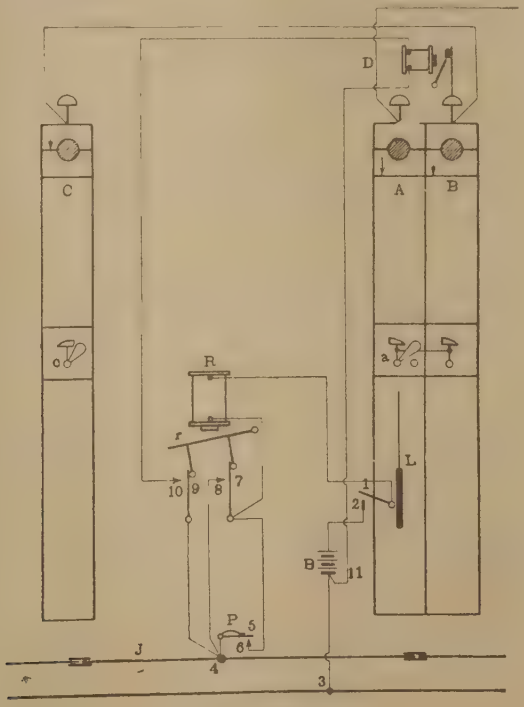


Fig. 63.

When the slot-gears A and B are unblocked, it becomes possible to set starting signal to "line clear" by throwing over the level L.

The train having departed, it is impossible to block the electric slot-gear B and to unlock the electric slot-apparatus C before the train has run over the insulated rail length and the signal has been again set to danger. Figure 63 shows the installation diagrammatically.

The electro-magnet D, of which the armature acts on the rod of the slot- apparatus B, is placed in a box above the slot-gear B; a relay R and a battery B are placed in the cabin.

The contact 1-2 is fitted to the pedestal of the signal-lever; the contact is closed when the signal stands at "line clear."

If a wheel of a train is on the insulated rail J and acts on the treadle P, the circuit — B, 3, axle, 4, 5, 6, relay, 1, 2, battery — of the current from the battery B is closed, the armature *r* is attracted, and the contacts 7-8 and 9-10 are closed.

After the wheel has passed over the treadle, the current in the relay continues to flow, because the circuit 3, axle, 4, 8, 7, R, 1, 2, has not been interrupted.

The electro-magnet D is not excited in either of these two cases because the circuit 11, electro-magnet D, 10, 9, 4, axle, 3, 11, is closed and D is short-circuited.

When the axle has left the insulated rail length, the current passes through the relay and the electro-magnet D; this current is interrupted at 1-2 when the signal is again set to danger.

The armature of the electro-magnet D is retained by a spring-catch after it has been attracted.

The electric slot-gear can be blocked while the armature is attracted. This operation having been performed it becomes impossible to block it again, because the catch is displaced.

The insulation of the rail is effected by means of oiled horn-beam fish-plates. These fish-plates are the same as those used by the Belgian State Railways and described in the number of the *Bulletin of the Railway Congress* for August 1904. Trials made with American fish-plates, in which the insulation is obtained by means of insulating material placed between the rail and the steel fish-plates, have given bad results.

The insulation obtained on a length of 24 metres (26 yards) (2 rails connected by fish-plates and copper connecting wires) has never fallen below 20 ohms. The relays have a resistance of 6·5 ohms. It is important that the connecting wires which connect the rails to the cabins should be of low resistance. To obtain perfect working of the relays, it is necessary that these conductors should be of copper wire from 3 to 4 millimetres (0·118 to 0·157 inch) in diameter.

[656 .257 & 656 .21 (01]

REPORT N° 4

(Great Britain and colonies, Belgium, France and Italy)

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SECTION *A*.

Improved central installations for the operation of points and signals.

I. — INTRODUCTORY NOTE.

It has been the custom to give the greatest freedom to the Reporters in interpreting the questions asked by the permanent Committee of the Congress.

In our opinion, section A of question X relates exclusively to central installations arranged for operating points and signals by means of power obtained from a power supply system. In fact, a serious beginning in the direction of progress and in the realization of improvements, worthy of the name, in the signalling arrangements of large stations only commences as soon as the signalman no longer has to use his own muscular effort; when, in English phraseology, " power signalling " has been adopted; or when, if the term be preferred, " fluid-operated cabins " have been installed.

This is also the interpretation adopted

*

by our colleague, Mr. E. C. Carter, who has drawn up the report on question X for the United States (1).

On the other hand, Dr. Ulbricht, the reporter for central, northern and eastern Europe, has entered into a preliminary investigation in which he has covered all the improvements made in existing installations of mechanical signalling (2).

Our colleague, Mr. L. H. N. Dufour, whose field only covered the Netherlands, in which country only limited trials have been made of fluid-operated cabins, was led to draw up a very complete and interesting monograph on the mechanical installations for operating points and signals in Holland (3).

We have in the first instance, in deference to our distinguished colleague, Dr. Ulbricht, drafted our detailed list of questions on that adopted by him. Unfortunately the countries over which our investigations extend, comprise a territory which is much less homogeneous than that which was reserved for Dr. Ulbricht to report upon.

The railways of Italy, France and England follow widely different methods in the arrangement of their mechanical signalling appliances. The replies received from them, — generally very brief, — reached us extremely late in most instances. To comment upon them properly, it would have been necessary to have obtained additional detailed particulars, the time for obtaining which was not available.

The methods adopted in various countries for mechanically operating points at a distance, were, moreover, set forth as far back as 1889 at the Paris Session by Mr. Sabouret, then Engineer of the central service of the permanent way of the Orleans Railway (1). A new investigation of this question would only offer interest if it dealt with details and compared, piece by piece, the arrangements adopted by the various railways. This question might be placed on the agenda of a future session. We will confine ourselves in the present instance to the study of fluid operated cabins.

II. — HISTORICAL NOTE.

A complete historical review of the different systems for operating points and signals by supply derived from a power distribution system, has been published by one of us in the *Bulletin of the Congress* (2).

In the present instance, we will confine ourselves to a few outlined descriptions drawn up in respect to the countries covered by our report.

The first method of power distribution utilised in Europe to supplement human effort was the water-pressure system of Bianchi and Servetaz. Numerous installations of this class are at work in Italy and on a few of the French railway systems.

Prior to this, the Westinghouse Company in the United States brought out the pneumatic system. The slowness of

(1) See *Bulletin of the Railway Congress*, number for March, 1910, p. 1337.

(2) See *Bulletin of the Railway Congress*, number for January, 1910, p. 295.

(3) See *Bulletin of the Railway Congress*, number for April, 1910, p. 1361.

(1) See *Bulletin du Congrès des chemins de fer*, number for July, 1889 (1st part), p. 653.

(2) See *Bulletin of the Railway Congress*, number for August, 1904, p. 651 : "Electrical interlocking of switches and signals at Antwerp Central station", by L. Weissenbruch.

transmission, however, soon led to the replacement of compressed air by water under pressure for setting in operation the track appliances. But this system soon gave place to an electro-pneumatic arrangement, in which electric current supplied at 16 volts was substituted for water under pressure for setting in operation and indicating the position of the track appliances. The system has been widely adopted in America and numerous examples of it are to be found in England; there is also an installation on this system in Paris at the French Eastern Railway station.

About 1902, the London & South Western Railway Company made a trial of a system in which low pressure air was used for operating and for setting in operation and indicating the position of the track appliances; the French Northern Railway Company also applied this system to their Ermont station, with the addition of pneumatic route-couplers (trajecteurs) arranged with a view to reduce the number of the levers.

It is only quite recently that entirely electrically operated installations have been adopted by some of the English and French railways and by the Belgian State Railway. Moreover, apart from this last railway, which, so far back as 1904 had a large number of applications of the Siemens and Halske system in its principal stations, the method is at the stage of undergoing comparative trials in England and in France. Amongst the electrical systems under trial in these two countries, we may mention :

In England :

The Crewe system, of which the London and North Western Railway and the North Eastern Railway each have one installation;

The Siemens and Halske system, of which two trial installations have been made — at Derby on the Midland Railway and at Didcot on the Great Western Railway; and the Siemens Brothers system, of which the first installation comprises two cabins having frames respectively of 224 and 80 levers at Birmingham (Great Western Railway).

In France :

The Taylor system, of which there is a trial installation on the Paris Ceinture Railway; the Ducousso and Rodary system in use on the Paris-Lyons Mediterranean Railway; the Bleynie-Ducousso system on trial at the St. Jean station, Bordeaux, on the French Midi Railway;

The Descubes system, recently placed on trial by the French Eastern Railway;

And, lastly, we must mention the trial recently made by the French Northern Railway of the M. D. M. system, using compressed air for operating the points and signals, and water under pressure for setting in operation and indicating the position of the track appliances.

III. — BRIEF DESCRIPTION OF THE METHODS OF OPERATING.

The greater number of these applications have been described in the technical press. We think, however, for the sake

of clearness in this report, that we can confine ourselves to a brief resumé of the methods worked out in these different systems for the operation of a set of points and of a signal as well as of the arrangement of their controlling lever-frames.

We think that this is the best method for examining these systems and thus obtaining an idea of the differences between them.

a) Bianchi and Servetaz System.

The Bianchi and Servetaz system uses water at a pressure of about 50 atmospheres as motive power operating the points and signals. The supply of water under pressure is stored in an accumulator supplied by a combined lifting and forcing pump which can be operated by hand in the case of small installations; a lever is arranged for this purpose in the cabin alongside the central apparatus. In the case of larger installations, the pump is run by a motor of 0·5 to 1·0 horse-power.

The accumulator is generally of sufficient capacity to enable fifty operations to be effected. In large installations, it will suffice for a hundred or even two hundred operations.

The pump draws the liquid from a sump into which the return conduit from the track appliances empties itself; the liquid passes through a filter so that it is freed from all impurities before being pumped a second time.

To avoid freezing of the fluid in winter, glycerine is mixed with the water; the percentage of glycerine to be added is decided according to the temperature.

Pure water is used when the temperatures are above 0° C. (32° Fahr.).

Operation of a set of points.—Figures 1, 2, 3, and 4 show clearly the various phases in the operating of a set of points. The stroke of the lever is divided into two stages. The second stage, which frees the mechanical interlocking arrangements, can only be effected after the indication of the position of the appliances has been shown in the cabin. With this object, the lever is arranged so as to be dependent on a differential piston, the slide valve of which is operated by the tongues of the points themselves.

In its thrown-over position (fig. 3) the points are only held in position by the pressure of the water against the larger piston surface. The points are not bolted in their extreme positions; those which are taken as facing points are fitted with a mechanical treadle (locking-bar) operated by the same apparatus as the points themselves; this apparatus in its normal position locks the point tongue against the point rail. This arrangement cannot be taken trailing. It may be supplemented by a mechanical detector acting on the signal transmission gear in cases where the latter is operated by wire transmission.

The two sets of points of the same track-connection (or crossover road) are operated by a single lever. In this case, the sets of points are operated in series, the operating fluid being admitted to the differential piston of the second set of points by means of the indicator slide valve of the first set of points which acts after these points have been operated; the slide valve of the second set of points sends indication of the position of the second set of points to the cabin, and permits the second stage of the movement of the lever to be effected.

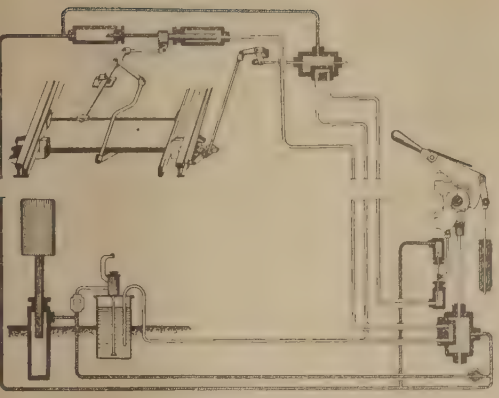

Fig. 1.
Normal position.

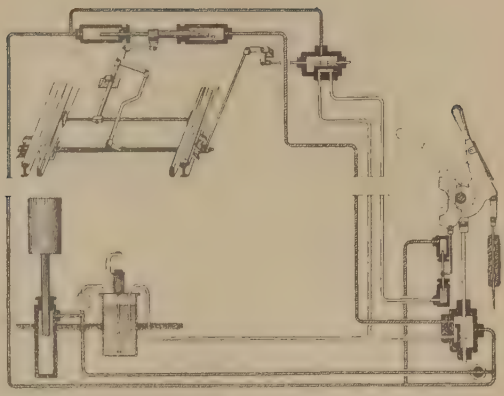

Fig. 2.
Lever thrown half-way over : points moving.

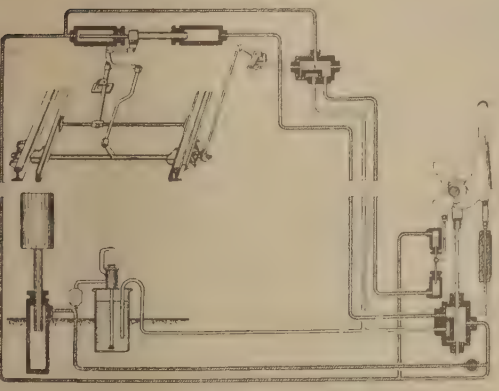

Fig. 3.
Lever thrown right over.

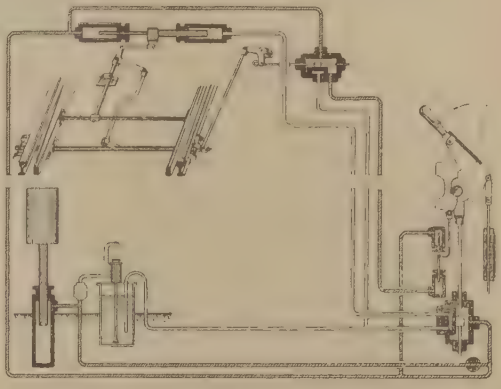

Fig. 4.
Lever thrown half-way back : points moving.

Figs. 1 to 4. — Set of points operated by the Bianchi and Servetaz system.

Operation of a signal. — The operation of a signal is shown diagrammatically in figure 5. The lever in the cabin only acts on a valve which puts the single conduit in communication with the source of water pressure when it is required to set the signal to line clear, and to exhaust when the signal is to be restored to its normal or stop position.

The operating gear consists of a single acting cylinder; the return to the stop position of the signal is performed entirely by the action of gravity.

In the case of signals at some distance

from the cabin, the operating gear is arranged close to the cabin and acts on the signal by means of a single wire transmission.

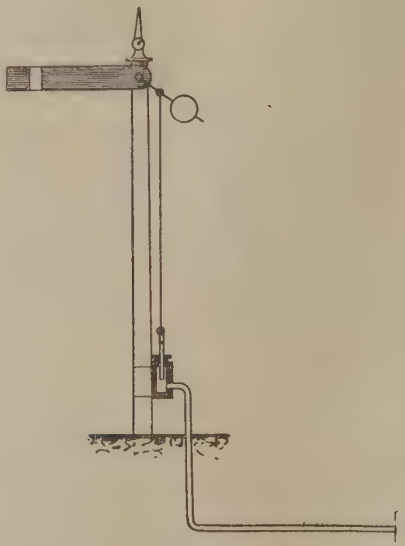

Fig. 5. — Signal operated by the Bianchi and Servetaz system.

Central apparatus. — The central apparatus for operating the appliances consists solely of the operating levers, placed side by side and connected together by a vertical interlocking frame on the Stevens system.

The admission slide valves as well as the differential pistons of the indicating appliances are arranged on the lower storey of the cabin; this also usually contains the appliances for operating the signals, the pump, and the sump.

On the French Northern Railway at the Valenciennes station, a system of hydrodynamic route-couplers has been fitted for operating the points and the signals of a complete or partial route by means of a single lever.

b) Low Pressure Pneumatic System.

The low pressure pneumatic system uses compressed air at a pressure of one atmosphere in the supply main for operating the appliances and of a half atmosphere in the conduits necessary for actuating the valves and for indicating the position of the points.

Operation of a set of points. — Figure 6 shows diagrammatically the arrangement for operating a set of points.

The movement of the lever L is divided into two stages; nevertheless the second stage of the movement is effected automatically, without assistance from the signalman, when the return from the indicator

conduit showing that the complete movement of the points has been effected, raises one of the piston p_1 or p_2 and consequently operates the slide block C of the point lever.

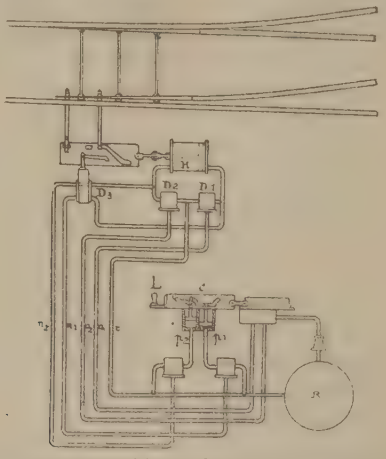

Fig. 6. — Set of points operated by the low-pressure compressed air system.

The operating gear of a set of points comprises five pipes, the conduit r from the compressed air reservoir R, two pipes $o_1 o_2$ for controlling the valves $D_1 D_2$ of the operating cylinder H and two pipes $n_1 n_2$ for indicating respectively the normal position and the thrown-over position of the points; this indication is ensured by the operation of the distributing valve D_3 connected to the points.

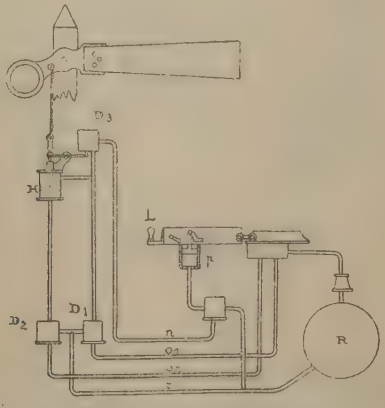

Fig. 7. — Signal operated by the low-pressure compressed air system.

Operation of a signal. — The operation of a signal is effected by means of a single acting cylinder; when a signal is to be set to line clear, the operation of the lever in the cabin is made in one stage, and in the case of the return to normal or stop position, in two stages, the second stage being performed automatically. Figure 7 shows diagrammatically the arrangement adopted. It is analogous to that adopted for operating the points, but has only a single pipe *n* for indicating the position of the signal when at danger.

Central apparatus. — The levers of the central apparatus work horizontally; they are interlocked with each other by means of a vertical frame on the Stevens system.

In France where an application of the low-pressure operating system has been made at Ermont, the individual actuating gear of the points and signals has been replaced with simultaneous operating gear for all the points and signals of a route by means of one or more pneumatic route-couplers analogous to those which have been employed in the hydro-pneumatic installations and in particular those at Valenciennes.

c) The M. D. M. Hydro-Pneumatic automatic route-combiner System.

The M. D. M. automatic route-combiner uses compressed air at a pressure of from 2 to 4 atmospheres for operating the points and the signals, and water at a pressure of from 5 to 12 atmospheres for operating the admission valves of the motors and the indicators of the appliances on the track.

Operation of a set of points. — Figure 8 shows a longitudinal section of the motor for a set of points.

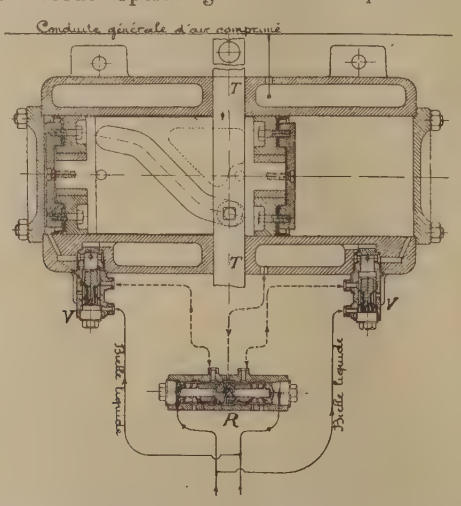

Fig. 8. — Operating gear for a set of points : M. D. M. system.

Explanation of French terms : Conduite générale d'air comprimé = Compressed air supply main.
Bielle liquide = Fluid connecting-rod.

It consists essentially of a bored cylinder with a jacket which serves as an air reservoir. Two pistons move air-tight in the cylinder and are connected to a slide in which a groove is formed; this slide drives the operating rod T which is connected to the point tongues.

Figure 9 shows diagrammatically the hydro-dynamic connections for a set of points.

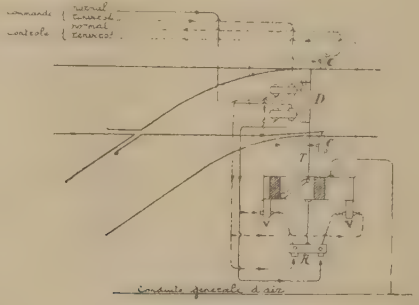

Fig. 9. — Diagram of the hydraulic connections : M. D. M. system.

Explanation of French terms : — Commande normale = Flow for operating normal. — Commande renversée = Flow for operating thrown over. — Contrôle normal = Flow for indicating normal. — Contrôle renversé = Flow for indicating thrown over. — Conduite générale d'air = Compressed air supply main.

The compressed air contained in the jacket is admitted alternately behind the one or the other of the pistons by means of a relay R and of the two valves V set in action by the hydro-dynamic mains coming from the operating keyboard in the cabin.

Each set of points is fitted with a switch D and point indicators C, which serve to show the indication of the position of the points in the cabin.

Operation of a signal. — The operation of a signal is effected by means of a single acting motor acting either directly on the arm of the signal, or at a distance by means of a single wire transmission.

This compressed-air motor is set in motion by means of a hydro-dynamic valve analogous to that used for operating the motors for the points.

Central apparatus. — The central apparatus consists essentially of :

1° An operating keyboard consisting of horizontal rows and vertical columns; each row corresponds to an arrival route and each column to a departure route, or vice versâ. At the intersection of the rows and of the columns, keys are arranged for operating the corresponding routes corresponding to the arrival road and departure roads to which they refer. The same key serves for two routes in opposite directions. According to whether the key is turned vertically or horizontally, the arrival signal or the departure signal is cleared after the signals affected by the route have been indicated in the cabin as being in the positions which they should occupy.

The keys are interlocked with each other in such manner as to prevent the simultaneous making of two routes which taken in combination with each other would be unsafe.

2° A *laboratory* consisting of a series of valves and conduits arranged on the ground floor of the cabin. It is here that the multiplication of the operations and the summing of the indications is effected. Figure 10 shows the arrangement of this laboratory diagrammatically.

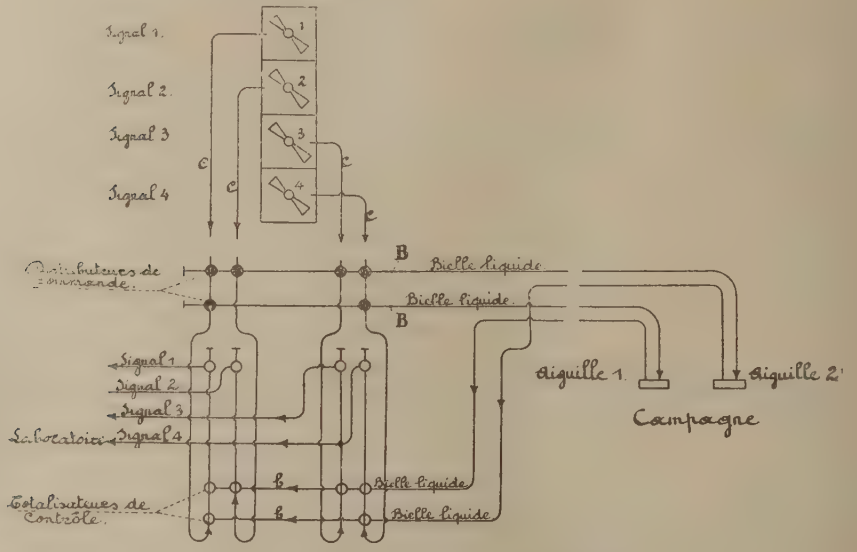

Fig. 10. — Diagram of the arrangement of hydraulic pipes and connections in the cabin : M. D. M. system.

Explanation of French terms : Signal = Signal. — Bielle liquide = Fluid connecting rod. — Aiguille = Set of points. — Campagne = On the track (the other details are in the cabin). — Distributeurs de commande = Valves of operatung gear. — Laboratoire = Laboratory. — Totalisateurs de contrôle = Apparatus for securing the indications received (totalizer).

d) The Westinghouse Electro-Pneumatic System.

The Westinghouse Electro-Pneumatic System employs compressed air at a pressure of about 5 or 6 atmospheres for operating the track appliances. The setting in operation of the track appliances and the indication of their position are ensured by means of an electric supply at about 16 volts.

The air compressors are generally operated by means of electric motors with automatic starting gear, so arranged as to start the motors when the pressure falls below a certain limit (4·5 atmospheres). As a general rule, a connection is fitted at some point on the air supply main, in order to permit of a supply being obtained

from the brake pump of a locomotive in case the regular pneumatic pump or its driving gear fails.

The electric supply is derived from two Tudor accumulator batteries which are alternately put in work and charged by a transformer group.

Operation of a set of points. — Figure 11 shows the pneumatic portion of the operating gear. The motor portion of the apparatus consists of a double acting cylinder, the piston of which is connected directly to the point tongues. The compressed air is led from the main to one end of the cylinder by means of an electrically operated valve, while the other end of the cylinder is opened to exhaust. An auxiliary reservoir containing a reserve of compressed air sufficient for several operations is fitted near each motor.

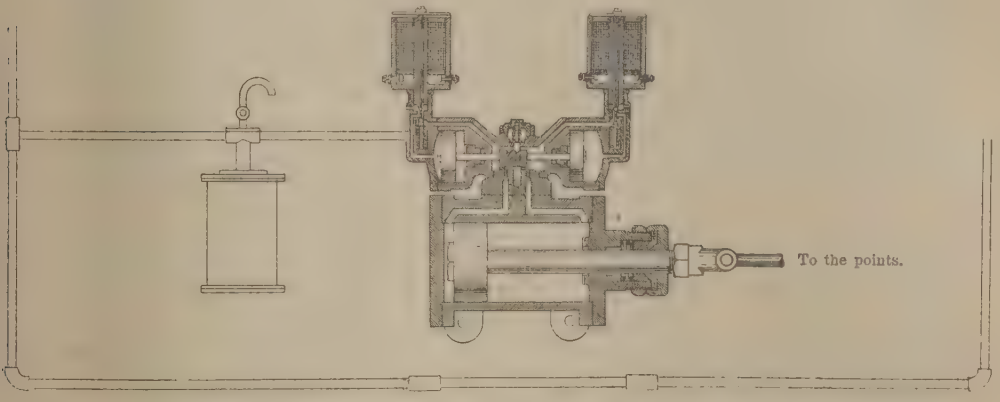

Fig. 11. — Operating gear for a set of points, Westinghouse system.

The points cannot be taken trailing. The motor apparatus first operates a bolt which locks the operating bar of the points before and after the points have been operated.

Figures 12, 13, 14 and 15 show diagrammatically the electric connections which connect the lever in the cabin to the motor on the track.

The connections between the operating gear and the lever consist of five wires; two are for operating, two are for indicating the position of the appliances, and one is the common return wire. The stroke of the lever is divided into two stages : the first stage of the stroke makes connection between the electric supply and wire 2; the operating electro-magnet R is excited and the motor apparatus is put in movement. The points operate the point tongue contacts b_1 and b_2, and, at the end of their stroke, connect wire 2 with wire 4; the current is shunted by this switch and excites the electro-magnet r in the cabin; the armature of this electro-magnet frees the lever and allows it to travel to the end of its stroke; this second movement operates the switch c_2.

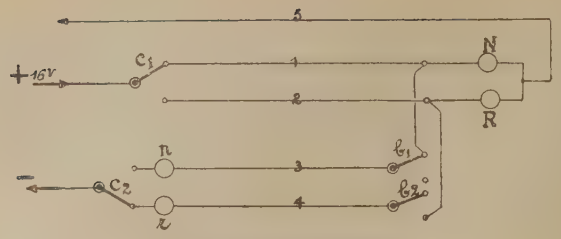

Fig. 12. — Normal position.

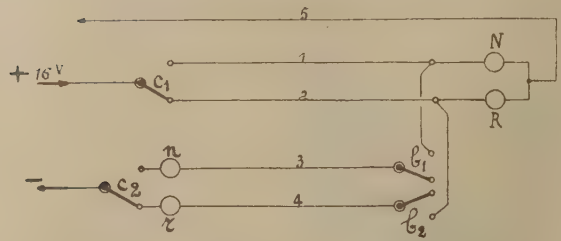

Fig. 13. — First stage of the operation : points moving.

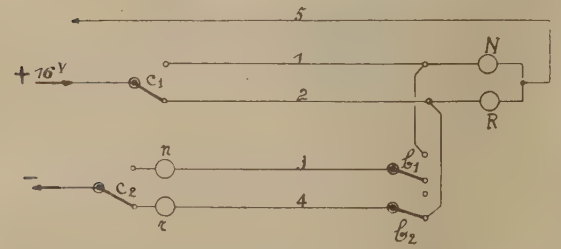

Fig. 14. — Points thrown over : released.

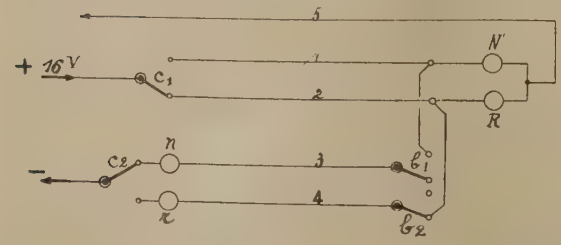

Fig. 15. — Thrown over position.

Figs. 12 to 15. — Diagrams of the electric connections for operating a set of points by the Westinghouse system.

A continuous current flows in each of the operating wires corresponding to the position of the lever and of the points.

Operation of a signal. — The operation of a signal is effected by means of a single-acting cylinder. Compressed air is admitted to the cylinder by means of an electrically operated valve; the return to normal or stop position is made by gravity, when the operating electro-magnet is no longer excited; the valve in falling on its seat opens the connection from the cylinder to exhaust.

The electric connections of the operating gear are shown diagrammatically in figures 16, 17 and 18.

By pressing on the latch handle of the lever, the signalman closes the cutout c_1 and the current excites the electro-magnet e, which frees the lever. The lever can then be moved, and closes the cut-out c_2. The electric current excites the operating electro-magnet A.

At the moment when the signal is set to line clear, the cut-out s opens the circuit of the electro-magnet e.

The operation of returning to normal or stop position is divided into two stages; the lever in the first stage opens

the cut-out c_2 and opens the circuit through the electro-magnet A; the signal being returned to normal or stop position by gravity, closes the cut-out s; the electro-magnet e is then excited by a current, attracts its armature, and allows the second stage of the travel of the lever to be performed.

Central apparatus. — The central apparatus consists of the operating levers for the points and for the signals arranged side by side and interlocked by means of a vertical interlocking frame on the Stevens system.

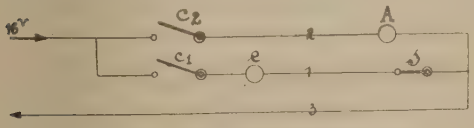

Fig. 16. — Normal position.

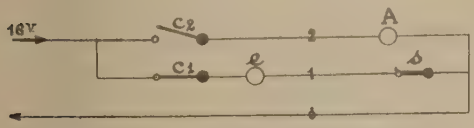

Fig. 17. — First stage of the movement of the lever.

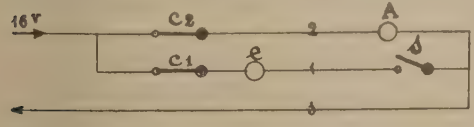

Fig. 18. — Signal at line clear.

Figs. 16 to 18. — Diagrams of the electric connections for operating a signal by the Westinghouse system.

In some cases, for operating the two signals protecting a single route, which can sometimes be run over in either direction, signal levers having three positions are used : in the normal position they are vertical and can be thrown over backwards for traffic in the one direction, and forwards for traffic in the other direction.

This arrangement has been adopted for operating the points at the Paris station of the French Eastern Railway; the direction in which the routes are to be run over is determined by the position of the levers capable of occupying three positions; this has permitted a simplification in the locking frame by utilizing to a great extent route-interlocking amongst the points according to whether they are run through in the one direction or in the other direction.

e) Webb and Thompson Electric System (Crewe System).

Operation of a set of points. — The Webb and Thompson system makes use of series-wound motors with single field-magnets for operating the points. The change of direction of rotation of the motor, necessary for ensuring the operation of the points in both directions, is obtained by reversing the direction of flow of the current in the armature by means of a switch operated by the lever of the central apparatus. The scheme of electric connections comprises six wires between the points and the cabin, as is shown in figures 19 to 22.

The stroke of the lever is divided into two stages. The first stage of the stroke operates the switches c_1, c_2 and c_3; the wire 1 is connected to the wire 3, and the wire 2 is connected to the negative pole of the battery. The same occurs with the wires 5 and 6.

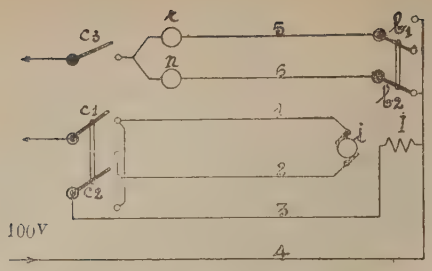

Fig. 19. — Normal position.

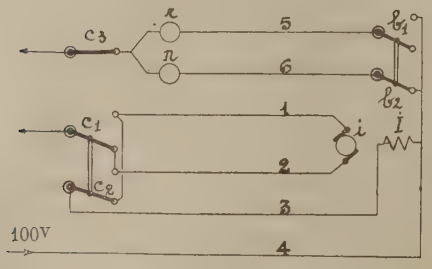

Fig. 20.
Lever thrown half-way over : points moving.

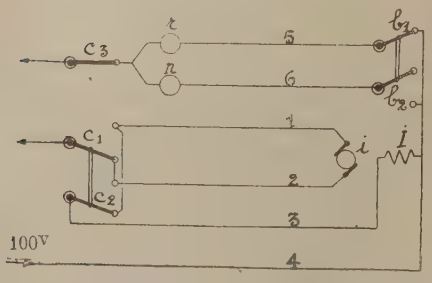

Fig. 21. — Point thrown over : the lever is released for completing the second stage of its movement.

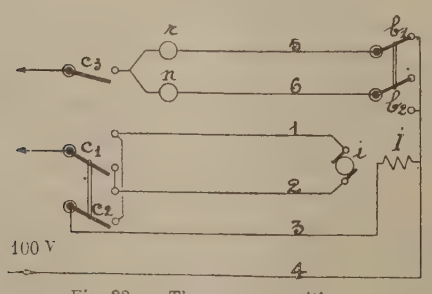

Fig. 22. — Thrown over position.

Figs. 19 to 22. — Diagrams of the electric connections for operating a set of points by the Webb and Thompson (Crewe system).

The motor revolves, and, having arrived at the end of its travel, operates the switch $b_1 b_2$; this insulates the wire 6 and connects the wire 5 to the wire 4 and to the positive pole of the battery. The electro-magnet r is excited and the lever can complete the second stage of its travel; this latter movement frees the mechanical interlocking gear and insulates the wires 1, 2, 3, 5 and 6.

The current necessary for operating a set of points is 20 amperes at about 100 volts.

A mechanical coupling is arranged between the motor and the points by means of which the motor is disconnected from the points when the latter have been operated and bolted, and turns free until the signalman has effected the second stage of the movement of the lever.

The points cannot be taken trailing.

Operation of a signal. — The signals are operated by means of single-acting solenoids. The return to normal or stop position is made by gravity.

The current passes through a switch, operated by the signal lever, and through detectors indicating the position of the point tongues in cases where the points are taken facing. At the end of its travel, the signal arm operates a switch which inserts a resistance in the circuit reducing the quantity of current to that necessary for retaining the signal in its line clear position.

The current necessary for operating the signal arm is 15 amperes at 100 volts; for maintaining the signal in its line-clear position 2 amperes only are required.

Central apparatus. — The operating

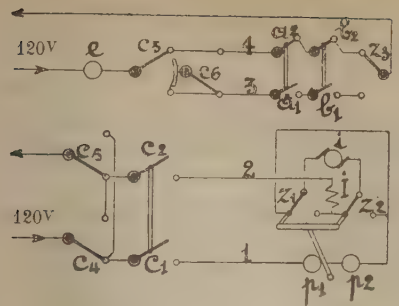

Fig. 23. — Normal position.

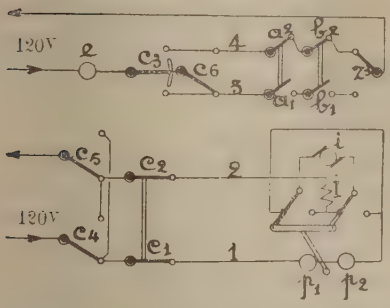

Fig. 24. — Lever thrown half-way over.

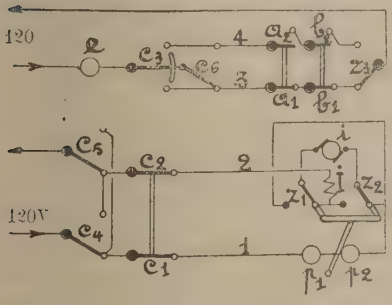

Fig. 25. — Points thrown over.

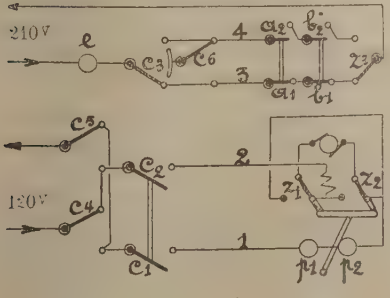

Fig. 26. — The thrown over part.

Figs. 23 to 26. — Diagrams of the electric connections for operating a set of points by the Ducousso and Rodary system.

levers, which are of the form of small Saxby levers, are arranged in two rows, one above the other, and operate, by means of vertical rods, bell-cranks connected to mechanical interlocking arrangements, also a series of carbon contacts for currents of large quantity, and lastly the interlocking arrangement for the indication of the position of the point tongues. The locking frame and all the electric portion of the installation are arranged below the floor-boards of the cabin.

The total height of the apparatus is only 3·30 metres. The connections between the central apparatus and the appliances on the track are formed by means of cables covered by metallic casing.

f) Ducousso and Rodary Electric System.

Method of operating the points. — The Ducousso and Rodary electric system also uses series-wound electric motors with single field-magnets for operating the points; the change of direction of running of the motor is obtained by means of a switch placed at the points and connected to the armature of a polarized relay.

The electric connections comprise 5 wires shown diagrammatically in figures 23 to 26.

The stroke of the lever is divided into two stages. The switches c_1, c_2 and c_3 are operated by the lever during its first stage of movement. They connect respectively the wires 1 and 2 to the two poles of the electric supply and form a circuit which flows through the polarized relay from p_1 to p_2; this relay, thus excited, attracts its armature which operates the switch z_1, z_2, z_3 and reverses the flow of the current in the fields I; the motor revolves and actuates the points.

When the points are in the thrown-over position, the point contacts a_1, a_2, as also the switch b_1, b_2, close an electric circuit and allow a current to flow which excites the electro-magnet e; the second stage of the travel of the operating lever can then be effected; it results in the movement of the switches c_1, c_2 and c_3 as well as of the switches c_4, c_5 and c_6 and prepares for the movement of the points in the opposite direction.

The points cannot be taken trailing; nevertheless in order to allow of the points being taken trailing, a Perdrizet spring is inserted between the points and the operating rod [1].

Operation of a signal. — The signals are operated by means of series motors running in one direction only; the signal is restored to normal or stop position by the action of gravity.

The arrangement of the electric connections comprises three wires. The stroke of the lever is effected in a single stage for setting to line clear, and is divided into two stages for setting to normal or stop position; the second stage of this operation freeing the interlocking arrangements can only be effected after the indicator in the cabin has shown that the signal has resumed its normal or stop position, by the flow of the indicator current. A mechanical ratchet gear acting directly on the balance weight with which the signal is fitted, prevents the signal from being put accidentally to line clear after it has been returned to its normal or stop position.

Central apparatus. — The central apparatus consists essentially of small levers of the Saxby type interlocked with each other by means of a Stevens frame.

g) Bleynie-Ducousso System.

The Bleynie-Ducousso system utilizes the same appliances as the system which we have just examined for the operation of the points and signals. The essential difference consists in the operating gear which comprises route levers, instead of individual levers, for operating all the points involved in the route by means of a single lever. The signals are, moreover, also operated by single levers interlocked with the route levers. The stroke of the route levers is divided into two stages, the second stage of the stroke can only be performed after all the points which require to be shifted for the completion of the route have been indicated as occupying the correct position by the flow of the indicator current. With this object, the indicator electro-magnet e (fig. 23) is duplicated for each set of points and the armature of each of these indicator electro-magnets operates a contact inserted in the circuit of the locking electro-magnet of the route lever. The second stage of the stroke of the route lever interrupts all the indicator circuits and closes a contact inserted in the operating circuit of the corresponding signal.

The stroke of a signal lever is made in one stage, when the signal is being set to line clear; moreover, if the route is protected by two signals (a stop signal and a

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[1] See " The electric operation of points and signals " by L. Weissenbruch (*Bulletin of the Railway Congress*, number for August, 1904, p. 651).

distant signal), the two signals are operated by the same signal lever, the stroke

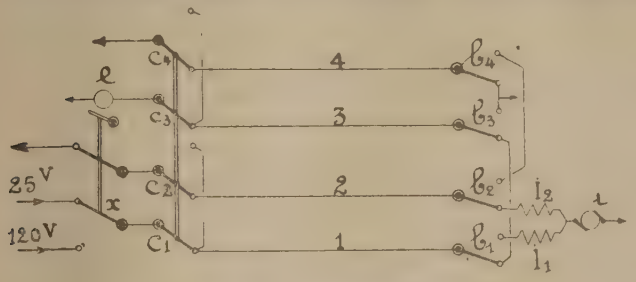


Fig. 27. — Normal position.

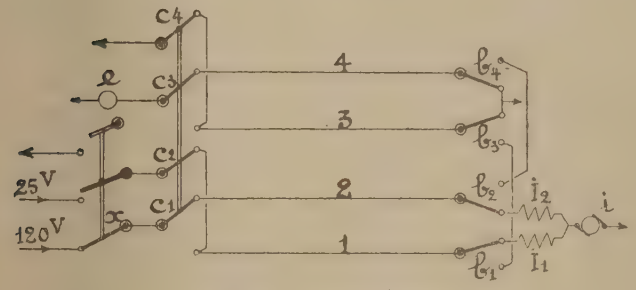


Fig. 28. — Points moving.

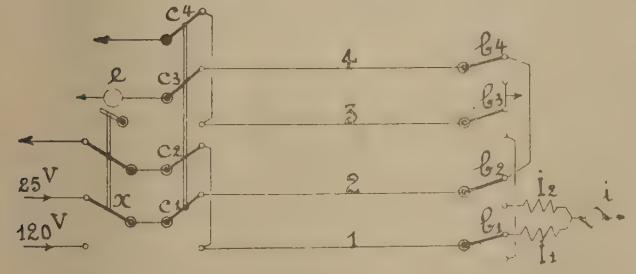


Fig. 29. — Thrown over position.

Figs. 27 to 29. — Diagrams of the electric connections for operating a set of points by the Siemens & Halske system.

of which is divided into two stages, the second stage of the stroke having the effect of putting the distant signal to line clear; this cannot be effected unless the first or danger signal is actually at line clear. The setting to normal position of the signal lever is effected in two stages, as in the Ducousso and Rodary system.

The route levers are mechanically interlocked with each other so as to avoid the simultaneous formation of two routes which in combination with each other would be unsafe.

In case of failure, a special frame is used, normally kept sealed; this allows the points to be operated singly.

h) Siemens and Halske System.

For operating the points and signals on the Siemens and Halske system series wound motors are used, with double field-magnets to obtain rotation of the motor in the one or in the other direction according to whether the one or the other of the fieldmagnets is excited by the current.

It is, moreover, arranged with a permanently flowing indicating current indicating the position of the points and of

the signals; the current used for this purpose is at a lower voltage than that used for operating the appliances.

Operation of a set of potnts.—Figures 27, 28 and 29 show diagrammatically the electric connections for the operation of a set of points. They comprise four wires connecting the appliance and the operating handle. The operation is performed in one stage. The indicator current at 25 volts flows normally through the wire 1, the switch b_1 depending upon the position of the operating lever, the switch b_3 depending upon the position occupied by the point tongues, the wire 3, the switch e_3 and the indicator electro-magnet e. The wires 2 and 4 through which the current does not flow, are connected to earth at one or both of their ends. It follows from this arrangement that no contact made with the wires can set the points in motion or give a wrong indication on the indicator.

Throwing over the lever results in changing the position of the switches c_1, c_2, c_3 and c_4. The electro-magnet e is short-circuited by the wire 4; the economising switch x substitutes current at 120 volts for the 25 volt current.

At the commencement of the operation, the switches b_1 and b_3 are thrown over allowing the points to be reset to their normal position without waiting for the completion of the movement. At the end of the operation, the switches b_2 and b_4 are thrown over and cause the 120 volt current to pass through 2, b_2, b_4, 4 and e; this electro-magnet being excited, attracts its armature which operates the switch x, and replaces the 120 volt current by current at 25 volts. The wires 1 and 3, which are not in use, are earthed.

The quantity of current used for operating is about 2·5 to 3 amperes at 120 volts; for indicating, it is 0·06 amperes at 25 volts.

Operation of a signal.— The signals are operated by means of appliances analogous to those used for operating the points; this renders it possible to avoid having recourse to the action of gravity for the return to normal or stop position. The signal is electrically operated both in the case of the return to normal or stop position and when set to line clear.

The operating gear acts on the signal disk or on the arm of the semaphore through an electric coupling which consists essentially of an electro-magnet, the armature of which, when excited, makes connection between the operating gear and the signal proper.

The coupling circuit passes through contacts which depend upon the position of the armature of the electro-magnets of the indicators of the points affected by the route.

Rupture of this circuit causes the signal to be set automatically to normal or stop position; this can also be effected by means of a rail contact actuated by the train; for this purpose, it is merely necessary to insert in the coupling circuit a contact depending on the position of the armature of a relay connected to this rail contact. It will be readily understood that still further additions may be required and easily realized by means of the coupling current for the signals. The quantity of current used for this purpose is about 0·25 amperes at 25 volts.

Central apparatus. — The central apparatus consists essentially of small hand levers for the operation of the points and of the signals, and also of auxiliary handles for the routes. The small hand levers for the points are interlocked mechanically with the hand levers of the routes, which in their turn interlock mechanically the hand levers of the signals. In appliances of the latest type, only the hand levers for points and for routes are usually fitted; these latter are operated in two stages, the second stage serving to set the signal to line clear.

The main function of the route hand levers is to retain the interlocking of the points after the signal has been thrown to normal or stop position behind the train; they also effect the selection of the various signals which can be given by a single semaphore mast; for this purpose they operate electric contacts, inserted in the coupling circuits of the signals, which permit the latter then to be operated by a single operating gear and a single hand lever in the central installation. They may also be interlocked by the train itself, in such manner as to remain locked during the whole period the train is running over them, being freed only after it has run over a rail contact acted on only by the last pair of wheels (see section B).

i) Siemens Brothers' System.

The Siemens Brothers' system which has been fitted some little time now on the Great Western Railway at Birmingham, uses motors with double field magnets for operating the sets of points, as in the previously described system, and single-acting appliances for operating the signals.

Operation of a set of points. — Figures 30 to 33 show diagrammatically the electric connections consisting of four wires. There is no permanently flowing indicator current, and the operation of the hand lever is effected in two stages. The first stage operates the cut-outs x_1 and x_2 and the switches c_1 and c_2, and completes the 120 volt circuit x_1, c_1, 2, b_2, I_2, and i to earth; at the commencement of the operating of the set of points, the switches b_1 and b_3 are operated and connect the wire 1 to the field-magnets I_2, and the indicator wire 3 to earth; at the end of the operation the switches b_2 and b_4 are operated, and complete an electric circuit through which a 120 volt current passes, exciting the electro-magnet n, the armature of which frees the operating lever; the second stage of the movement of the lever restores the cut-outs x_1 and x_2 to their normal position.

Operation of a signal. — The principle employed for the operation of a signal is analogous to that of the Ducousso and Rodary system. Figures 34 to 38 show diagrammatically the electric connections which comprise only two wires for each signal arm, the return being rendered unnecessary by earthing the negative pole of the battery.

The operation of the hand lever is effected in one stage for setting the signal to line clear; it operates the cut-outs x_1 and x_2 and the switch c_1 and c_2; current flows through the wire 1, excites the coupling electro-magnet A, and causes the motor to revolve. This circuit includes the contacts d, d', operated by the tongues of the points affected. At the commencement of the movement of the signal, the

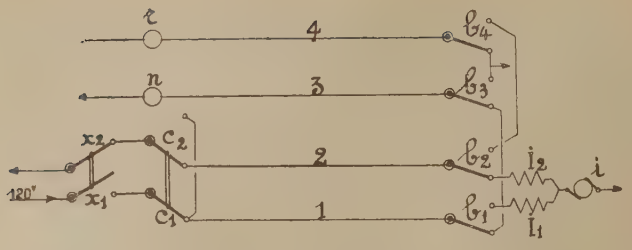


Fig. 30. — Normal position.

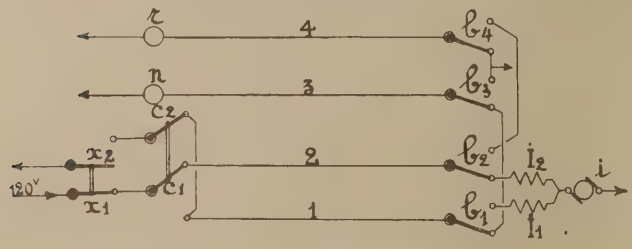


Fig. 31. — Lever thrown half-way over.

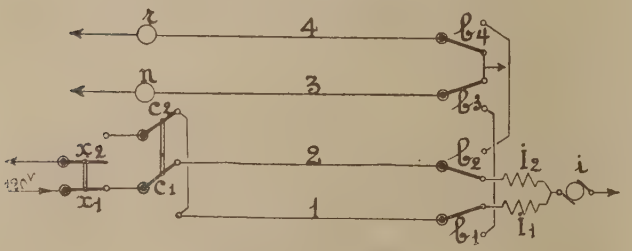


Fig. 32. — Points moving.

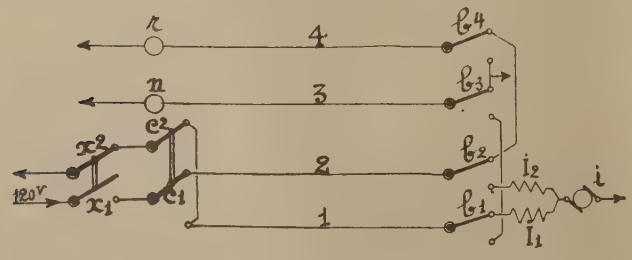


Fig. 33. — Thrown over position.

Figs. 30 to 33. — Diagrams of the electrical connections for operating a set of points by the Siemens Brothers' system.

switch b_2 is operated and the wire 2 is insulated from earth; when the signal is set to line clear, the switch b_1 is operated and interrupts the motor circuit. The arm is retained at line clear by the coupling circuit A.

To return the signal to normal or stop position the switch c_1 and c_2 is operated by the first stage of the movement of the hand lever; the coupling current A is interrupted and the arm falls back under the action of gravity, operating the switches b_1 and b_2; the locking electro-magnet e is excited by a current and frees the operating lever which can be thrown back to the end of its travel; this operates the cut-outs x_1 and x_2.

Central apparatus. — The central apparatus comprises the levers for operating the points and those for operating the signals, interlocked with each other by means of a vertical locking frame. The arrange-

ments of the central apparatus are so combined as to take up the minimum of space; the width of the apparatus only measures 30 centimetres (1 foot), and the levers are spaced only 5 centimetres (2 inches) from each other.

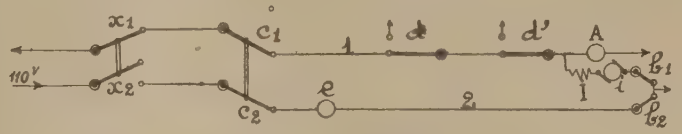


Fig. 34. — Normal position.

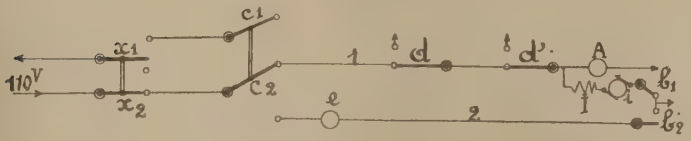


Fig. 35. — Lever thrown over : Signal operating gear moving.

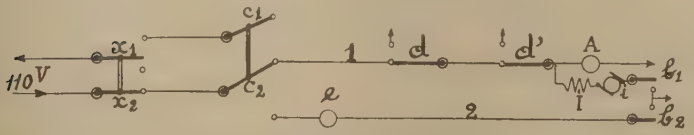


Fig. 36. — Lever at line clear.

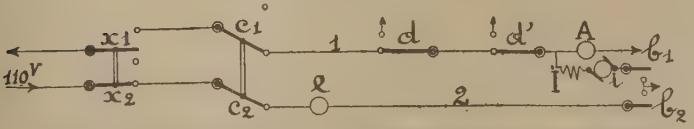


Fig. 37. — Lever half-way thrown back for returning to normal position.

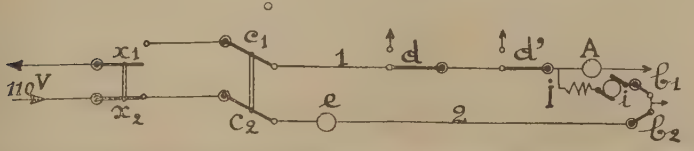


Fig. 38. — Signal at stop position; the second stage of the movement of the lever can be performed.

Figs. 34 to 38. — Diagrams of the electric connections for operating a signal on the Siemens Brothers' system.

j) Taylor's System.

The Taylor system, of which an installation has been fitted on trial in France on the Paris Ceinture Railway, also effects the operation of the points and of the signals by means of series-wound motors with single field magnets.

Operation of a set of points. — The operation of the point lever is effected in two stages. The indication of position of the appliances which is of positive character is obtained at the end of the travel by short-circuiting the motor, which then works as a dynamo, producing current which frees the lever for its second stage of operation.

Figures 39 to 42 show diagrammatically the electric connections which consist of three wires, two for operating and one serving as the common return wire.

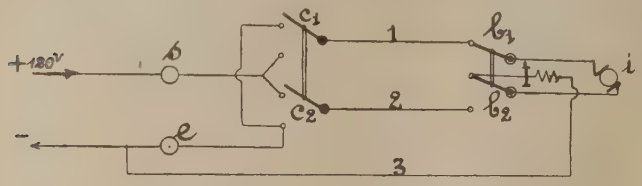


Fig. 39. — Normal position.

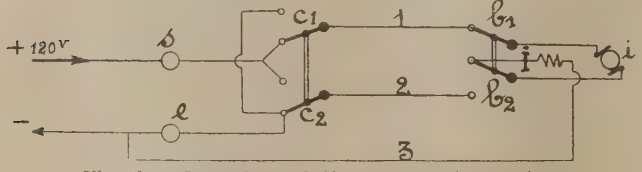


Fig. 40. — Lever thrown half-way over : points moving.

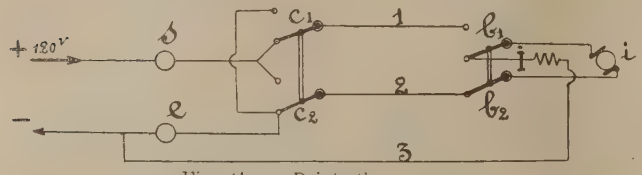


Fig. 41. — Points thrown over.

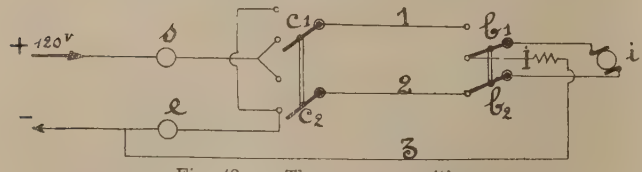


Fig. 42. — Thrown over position.

Figs. 39 to 42. — Diagrams of the electric connections for operating a set of points by the Taylor's system.

The first stage of the movement of the lever operates the switches c_1 and c_2 and completes the operating circuit in which current flows through the safety electro-magnet s, the wire 1, the switch b_1, the armature i, the switch b_2, the field magnets I, the wire 3 to the negative pole of the battery. At the end of the travel of the motor, the switches b_1 and b_2 are operated, short-circuiting the motor by the wires 2 and 3 and short-circuiting the indicator electro-magnet e; the current generated by the motor when running as a dynamo excites the electro-magnet e; freeing the second stage of movement of the hand lever; this second stage of the movement maintains the switch c_1 and c_2 in position, and insulates the wires 1 and 2.

The armatures of the electro-magnets s and e are connected to each other.

Operation of a signal. — The operation of a signal is effected under conditions absolutely analogous to those used in the

Ducousso and Rodary and the Siemens Brothers' systems; the signal is returned to normal or stop position by the action of gravity alone, but the interlocking gear is only freed after the indicator current, the circuit of which is completed at the moment at which the signal returns to its normal or stop position, has allowed the second stage of the movement of the signal lever to be effected.

Central apparatus. — The central apparatus comprises horizontal slides interlocked with each other by means of a Stevens locking frame with inclined tappets. This arrangement makes the handling of the levers somewhat heavy when compared with that of the other systems.

k) Simplified Electrical Systems.

In order to render more easy the comparison of the different systems using electrical circuits which we have enumerated, we have shown the connections diagrammatically with a simplified notation which has enabled them to be reduced to a very few lines. Figures 43 to 48 show for each of the systems the normal position of the cut-outs and switches. The signs and abbreviations used are shown on the next page.

IV. — COMPARISON OF THE VARIOUS SYSTEMS.

The following general deductions can be drawn from the abstracts which we have just given.

Operation of points. — In fluid-operated cabins, the operation of points is effected actually either by means of water under pressure, or of compressed air, or of electricity.

The advantages and disadvantages of these different methods of control at a distance are too well known for us to enter into lengthy examination of them. In the case of water under pressure and of compressed air, piston motors are used in which the to and fro movement can be transmitted directly to the point tongues or to the signals, whereas in the case of electricity, the use of solenoids has been generally rejected, and motors are used in which a movement of rotation is transformed into a movement of translation by means of gearing consisting of toothed wheels and a rack. But the apparent advantage offered by water and compressed air is largely compensated by the disadvantages inherent to these two methods of power transmission. The disadvantages are due to the leakages which occur at the joints of the pipes and at the piston rings, difficulties in affecting the replacement of one motor by another in case of failure, and difficulty in effecting the maintenance of these appliances, and more particularly in the case of water under pressure, the care which must be taken to prevent freezing in winter. It should further be added that the differential principle when applied to some installations is dangerous, because a point tongue may be set in movement unintentionally through a fracture of the supply main.

From all these points of view, it is indisputable that electricity offers the greatest number of advantages in practice.

Our colleague in America, Mr. Carter, states the same, although compressed air has found very many applications in that country.

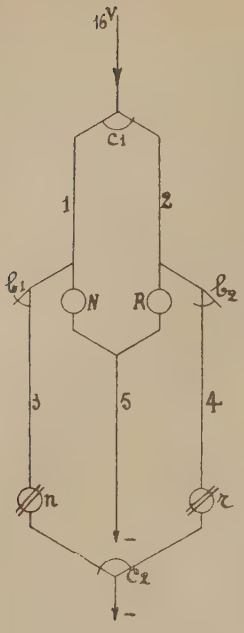


Fig. 43.
Westinghouse system.

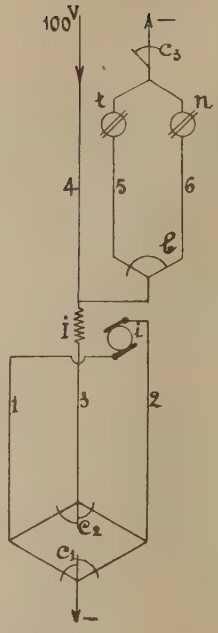


Fig. 44.
Webb & Thompson system.

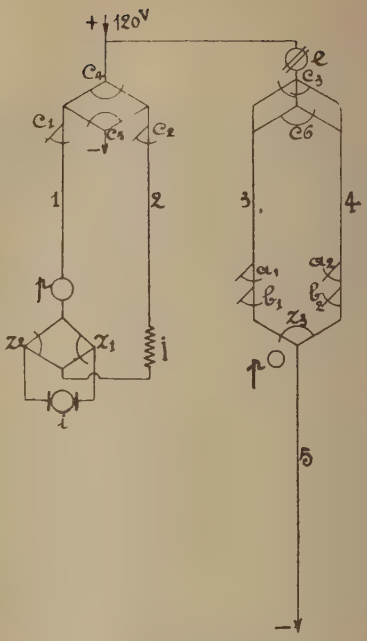


Fig. 45.
Ducousso & Rodary system.

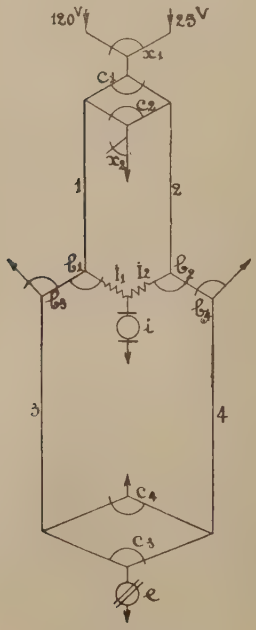


Fig. 46.
Siemens & Halske system.

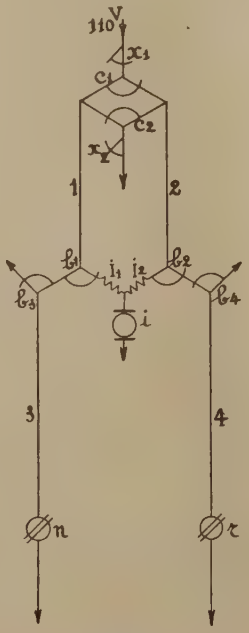


Fig. 47.
Siemens Brothers' system.

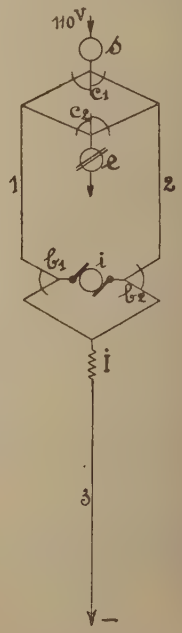
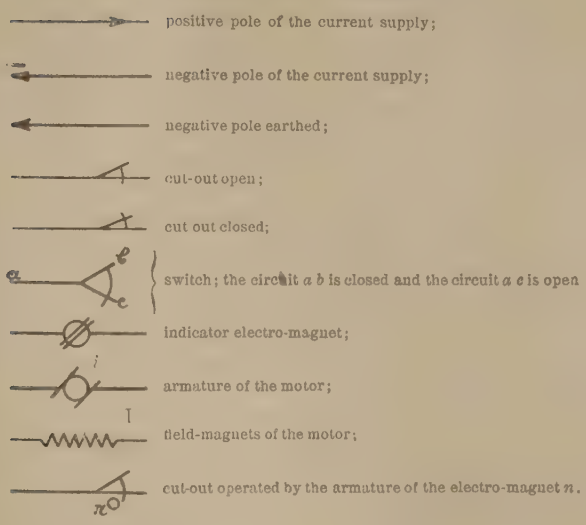


Fig. 48.
Taylor's system.

Notation adopted in figures 43 to 48.


positive pole of the current supply;
negative pole of the current supply;
negative pole earthed;
cut-out open;
cut out closed;
switch; the circuit a b is closed and the circuit a c is open
indicator electro-magnet;
armature of the motor;
field-magnets of the motor;
cut-out operated by the armature of the electro-magnet n.

In a new system now on trial at Praed Street Junction and at Aldgate on the Metropolitan Railway in London — the Johnson system — the electric motor sets in motion a column of mineral oil which acts on a differential system connected to the points to which it transmits its movement directly.

This appears to be a complication which s not likely to obtain many applications. This system, moreover, utilises the differential principle which gives rise to a certain amount of risk.

Indicators. — All the systems in use include indicators for showing the position of the track appliances. This indication is generally effected electrically, which enables the indication to be performed instantaneously when the track appliance has come to the end of its travel.

In the low pressure pneumatic system, the indication requires as much as twenty seconds. In the system using water under pressure, the hydraulic indicator, which frequently takes from ten to twelve seconds to effect the indication has been retained. The M. D. M. system utilizes hydraulic indicators by means of a fluid connecting rod which is relatively speedy.

The fault which might be found with the electrical indication is that it might have the serious disadvantage of giving the indication at a wrong time in the cases either of crossing of the wires or of defective insulation of the conductors, and it would seem that the attention of all the designers has not been equally carefully given to this very important point. We ought, in fact, to note that with the exception of the Siemens and Halske system and the Siemens Brothers' system, no special precaution has been taken for guarding against the consequences of

contacts made by crossed wires whether momentary or permanent. In both the latter systems, the danger of a false indication due to crossing of the wires is rendered impossible owing to the earthing of the negative pole of the battery, which enables all those portions of the appliances most necessary in respect to safety, to be connected to earth; such are the armature of the motor, the indicator electro-magnets and the coupling electro-magnets of the signals, the contacts closed by the point tongues, etc., as well as those wires through which no current is flowing. It follows from this arrangement that *in no case* can defective insulation of a conductor or crossing of the wires cause dangerous indications : these two classes of disarrangement can, in fact, only have the consequence of short-circuiting to earth those portions on which the safety of the systems depends. It might further be objected that the earth contacts in question could also become insulated, but it would be easy to apply electric tests to these if it were desired to guard against this extremely improbable event.

In general terms, the indication is effected positively or is maintained continuously. In the first case, it acts only at the end of the stroke of the appliance operated and ceases immediately after the second stage of the movement of the lever has been effected, the second movement being impossible until the indication takes effect. It is, in fact, essential to operate the levers in two stages when no permanently flowing indicator current is used, in order to avoid liberating the mechanical interlocking before the indication of the operation has been received.

The operation of the lever in the cabin in two stages is therefore an *inevitable* consequence of the positive control.

In the second system, which uses a permanently flowing indicator current, the operation of the lever can be effected in a single stage, and constant electric relations are maintained between the position of the point tongues and their actuating apparatus on the one hand, and the lever in the cabin on the other hand. This relation can also be utilized to prevent the setting to line clear of signals before the position of the points affected has been indicated; in this manner, it is very simple to obtain the detection of the points as required in the most modern specifications, particularly by the Board of Trade in England and by the State in Belgium.

On the Paris Ceinture Railway on which the Taylor system has been fitted on trial, the Company has required the addition of the Hall Automatic Block system with point tongue detectors in order to assure the same degree of safety as is obtained in Belgium by the permanently flowing indicator current.

Lastly, we think we should mention that at Yarnton Junction on the Great Western Railway, an electrical system for operating points and signals has been recently applied which makes use of a permanently flowing indicator current and consequently allows of the operation of the levers in a single stage.

Operation of a signal. — As a general rule in France and in England, the signals operated from fluid operated cabins are only actuated by single-acting appliances; the return to normal or stop position is effected in each case by gravity alone. All the systems employ the positive indica-

tion showing the setting to normal or stop position of the signal, and this requires that the operation of the signal lever for its return to the normal position should be effected in two stages. The Belgian State Railway on the other hand, makes use of double-acting appliances which obtain a degree of safety analogous to that obtainable with mechanical double-wire transmission in conjunction with automatic return to normal or stop position in the event of the breakage of a wire; this latter condition is obtained by an electric clutch gear, interposed between the signal and the actuating gear. Moreover, in new installations, an electrical interlocking is arranged between the position of the signal and the auxiliary route-lever in such manner that the latter can only be returned to its normal position — and consequently free the mechanical interlocking of the point levers — when the signal has been previously and effectively returned to its normal or stop position.

Arrangements of central apparatus. — The central apparatus generally consists of individual operating levers for operating the points and the signals. The Siemens and Halske system comprises in addition the auxiliary route-levers; but as we have already shown, these levers are used to economise signal levers by making a selection between the various indications which could be given by a single semaphore, and actually they replace the numerous levers which would be necessary if each arm and each direction number required to be operated specially.

In France several Companies and in particular the French Midi Railway, the French Eastern Railway and the French Northern Railway are following up the trials made and abandoned (1) in Germany in 1895 of the appliances of Westend, Untertürkheim and Dresden, for operating all the points and signals of one route by a single lever. We have already briefly described the general principle of the Bleynie-Ducousso system, which has been designed with this object and applied at the St. Jean station at Bordeaux (2). We have also mentioned in the same connection, the arrangements used at the Ermont and Valenciennes stations on the French Northern Railway. The general principle on which these arrangements are based is as follows :

A route is settled when the three following factors are known : the arrival road, the departure road and the direction of running. Now there are always a certain number of manœuvres which have one or two of these factors identical; consequently, in allotting a certain lever to a definite factor, this lever can be used indifferently for all manœuvres which include this factor. It follows that it is only necessary to provide one lever either for a complete route, or for a portion of a route, which will operate the whole of the points and signals affected.

The Descubes system, on trial on the French Eastern Railway, is still more radical in respect to the number of levers which it uses. The number of levers is, in fact, equal to the sum of the number of arrival roads to the zone protected by

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(1) See « The Electric operation of points and signals, etc. ». (*Bulletin of the Railway Congress*, August, 1904, p. 651.)

(2) The German patent No. 83559 taken out by Siemens Brothers' but now expired, we believe, expresses this principle in terms remarkably similar to those used in Mr. Bleynie's specification.

the cabin, added to the number of departure roads from that zone. Any route is made by operating two levers corresponding to the ends of the route desired. These levers can occupy three positions, one normal and two thrown over. To make a route from A to X the signalman first operates the lever X by throwing it over towards him, and afterwards the lever A by throwing it over towards him through its first stage of travel; when the points have moved the indicator current is completed and unlocks lever A; the signalman can then complete the second stage of movement of the signal, which sets the corresponding signals to line clear. The operation of the points and of the signals is effected by means of electric motors.

Finally, quite recently the French Northern Railway have put on trial at their Paris station, a system of route levers — the M. D. M. automatic route-combiner — which, by its keyboard certainly affords the smallest operating board, and that which is the easiest to operate, imaginable. A brief description of this keyboard is given in the *Bulletin of the Railway Congress* (1).

The trials to which these new arrangements have been subjected are as yet too recent to enable us to draw definite conclusions as to the efficaciousness of the appliances.

We think, however, that we may make the following remarks relating to the ultimate general adoptions of these systems of route levers :

1° The employees in charge of the operation of the ordinary central apparatus of a station do not need to go through an apprenticeship so complicated or so difficult, provided that they are men of average intelligence *acquainted with the reyular traffic* in the zone to be operated on. It is this knowledge of the traffic which is indispensable and which must be obtained before a man can be trusted to learn the handling of the apparatus.

It would appear that some of the French engineers have been guided by the idea of being able to use anyone as signalman in case of a strike. But a man who was not thoroughly familiar with the traffic of the station could not effect any manœuvres other than the most simple ones, and those only provided that the electricians have not done any rattening. If the latter can be depended upon, they can always take the place of the signalmen. If they cannot be depended upon, the apparatus will be paralysed.

2° The working of the appliances at a station, no matter what system is employed for operating them, is inevitably subject either to disarrangement or to minor trouble requiring attention. These troubles are particularly due to the conditions under which many of the appliances on the track have to work; in particular, vibration due to the passing trains, dust from the ballast, the relative movement of different portions of the track, bad weather, etc. Periodic inspection is rendered necessary more frequently the more strict the conditions required for safety; it follows that it is frequently necessary to

(1) " Note on the double application of the M. D. M. automatic route-combiner to the hydraulic operating gear and to the interlocking of the points and signals at the Landy signals cabins, near Paris, by the French Northern Railway ", by A. Moutier. (*Bulletin of the Railway Congress*, Nos. 8-9, July-August, 1910, p. 3311.)

operate a track appliance singly for purposes of maintenance, and this can be done much more easily when the appliances are operated singly than when they are operated by route levers.

3° The economy of time which would appear to result from the making of a route in the route lever system, as compared with a system using individual levers, these levers being operated in a single stage, is an illusion. In fact, this time includes in both cases :

a) The time necessary for operating the points — which in both cases takes place in parallel — and for sending the indicator current which frees the operating gear of the signal;

b) The time necessary for operating the signal to set it to line clear.

It has been found by numerous trials which we have made, particularly at the Brussels Northern station, that the complete making of the most complicated routes never takes more than eight seconds, comprising :

Four seconds for operating the points and the auxiliary route levers;

Two seconds for setting the signal at the end of the route to line clear, which must be performed before the starting signal moves, and

Two seconds for setting the starting signal to line clear.

At the Valenciennes station, some routes require as much as thirty seconds for their completion.

4° So far as economy in the staff for operating the central apparatus is concerned, we think that this depends more on the quantity of traffic to be dealt with than on the dimensions of the apparatus to be handled. It is to be noted, in fact, that in fluid-operated cabins, the signalmen become just as tired as in the others although there is no muscular force to be exerted; this must therefore result from the mental effort which they have to exert to ensure the necessary sequence of operations.

5° Finally, in regard to the maintenance of the appliances, we think also that no economy results from the use of this or that system of operating levers; these systems only differ in the arrangement of the central apparatus, which should be under the best conditions for maintenance; we shall return, moreover, later, to the important question of cost of maintenance of fluid operated cabins.

We think that we may conclude that, in spite of the ingenuity which has been devised with a view to substituting route operation for single lever working, the advantages of the latter system are such that owing to the conditions of the problem to be solved, they will finally prevail. It is essential, moreover, that individual operation should be arranged so as to reduce to the minimum the number of operations to be made by the signalman and so as to enable them to be made as rapidly as possible. Consequently it is necessary that the apparatus should be operated in a single stage and that the indication in the cabin of the position of the appliances on the track should be effected electrically.

Besides this, we must remark that even the idea of appealing to the reasoning faculty, rather than to the memory of the

signalman for the formation of a route, is not rational.

It is a well known fact that if the operations are to be performed with great rapidity it is only by the reflex actions and not by the brain effort of the signalman that this result can be obtained. Thought should only be involved in those cases where the operations require initiative.

Failures. — As we said at the commencement of this Report, the brief replies we received to our list of questions, arrived so late that it was impossible for us to obtain supplementary details. It follows, consequently, from these replies, that the troubles which have been found in fluid-operated installations for working points and signals are few in number and not of serious importance.

In the hydraulically and pneumatically operated cabins, leakages have been the most frequent source of trouble, and have occurred especially at the joints of the pipes and at the packing of the pistons. In the electrically operated cabins, failures or troubles are due to faulty contacts, slacking of terminals, damage to cables, blowing of fuses owing to excessive resistance to movement, failure of indication due to the presence of foreign matter in the points, or to shifting of the track, etc.

We now come to a similar conclusion to that of our distinguished colleague, Dr. Ulbricht: it is that the greater number of troubles are due not to the use of electricity, but to disorganization of the track and of the points, of which the electrical appliances give a valuable indication. In those stations in which these have been introduced in Belgium, it has been found necessary to improve the condition in which the track is maintained, and derailments of locomotives have been entirely prevented. If it is desired to make a comparison with the ordinary mechanically operated installations, the fact must not be lost sight of that in the latter those troubles which the permanent way staff are accustomed to put right themselves, are not considered as failures, for example, the breakage of a transmission wire, a wire slipping off the compensating pulley, jamming of a lever, etc.

First Cost. — The first cost varies greatly between different installations, and is evidently dependent on the conditions required for the working of the traffic. Consequently, it is not possible to make a comparison between the various replies which we have received on this head, except where they relate to similar installations in respect to the signalling arrangements, the mean distance at which the points are operated, etc.

Dealing only with the Belgian installations, these give extremely complete arrangements for ensuring safety. All operations of moving trains are made to signal. The stop signals are always supplemented by distant signals. All routes are cleared automatically by the trains. At Brussels Northern station, all the tracks are insulated. The signals return automatically to danger behind the trains, etc.

We may mention that from the information received, the cost of installations operated hydraulically varies, in France from 2,217 to 2,500 francs (from £88.14*s.* to £100) per lever, and in Italy from 1,800 to 2,000 francs (from £72 to £80); that of an electro-pneumatic installation in Eng-

land varies from 2,075 to 3,500 francs (from £83 to £140) per lever.

In the installation at the St. Jean station, Bordeaux, on the Bleynie-Ducousso route system, the cost amounts to 2,250 francs (£90) per route lever, but the mains will require to be replaced by lead-covered cable, which will considerably increase the cost of the installation.

The installation of the two cabins at Villeneuve St. Georges on the Paris-Lyons-Mediterranean Railway, has required an expenditure of 770,000 francs (£30,800) for operating 45 sets of points and 62 signals; this amounts to 7,200 francs (£288) per appliance operated.

Finally, the last installation on the Siemens and Halske system, now being laid down at Alost in Belgium, will only cost 408,000 francs (£16,320) for 60 sets of points and 135 signals (single arms, track number arms and shunting arms), which amounts to about 2,100 francs (£84) per appliance operated, including the cost of the semaphores and of the plant for generating the current.

No conclusion can be drawn from figures which vary so much; they do not give more information than those which are quoted by our colleague Mr. Dufour at the end of section A of his report. However, we think it as well to go into some detail on the subject of the cost of the signalling arrangements now being laid down at the Alost station, in order to enable us to understand the advantages in economy of power-operated installations in comparison with the hand operation of points and signals at a large station.

This station, which comprises eight passenger tracks and a locomotive siding, is situated on the fast traffic line from Brussels Northern station to Ghent; moreover, two single tracks and one double track run into this station. In addition, at one end the station is connected to the Alost East Goods station, and at the other end to a group of sidings for coaching stock.

The operation of all these signals and points, which cover a length of about 1,200 metres (1,310 yards), is concentrated in a single cabin crossing the tracks, situated at the centre of the length of the passenger platforms, and fitted with an electric installation on the Siemens and Halske system.

To operate these appliances by hand would have required the construction of four cabins, comprising respectively 63, 110, 170 and 38 operating levers; these would have involved an expense of about 400,000 francs (£16,000), including the cost of construction of the cabins, notwithstanding the low first cost of Saxby appliances in Belgium.

The electrical installation has involved a total expenditure of 440,000 francs (£17,600), including the cost of the single cabin (1).

The extra expenditure in capital has therefore been only 40,000 fr. (£1,600), but it would have been saved after nineteen months' working. In fact, the cost of working, which amounts to about 48,000 francs (£1,920) per annum in the case of manual operation of the appliances, becomes reduced to about 22,000 fr. (£800) for electrically operated appliances. There is consequently an annual

(1) The figure 408,000 francs (£16,320) quoted supra does not include the cost of construction of the cabin itself.

saving of about 26,000 francs (£1,040) or 2,166 francs (£86.13*s.*) per month and 41,156 francs (£1,646.5*s.*) in nineteen months.

Cost of Working and Maintenance. — In general, the cost of working and maintenance comprise :

1° The wages of the employees responsible for operating the appliances;

2° The wages of the employees responsible for maintaining the appliances;

3° The supply of power necessary for operating the appliances;

4° The amount allowed for depreciation and for material required for maintenance.

We should note that as a general rule the greater number of railway companies consider it necessary to employ a special man in regular attendance to look after the maintenance of the appliances at a station. It is considered necessary to have such a man in order that it may be possible to set right immediately any trouble which may occur. Moreover, it is essential that the appliances should always be maintained in perfect order, and in this respect installations using a power supply have, in our opinion, an undeniable advantage over installations operated by hand; this arises from the fact that they indicate, almost automatically, the performance of the work of maintenance. The employee whose duty it is to ensure this maintenance, is constantly on the alert, and under the necessity of carrying out his duties with scrupulous care.

The supplementary expenses caused by the necessity of the continuous employment of this specialist are largely compensated for by the certainty that the installation is always kept in perfect order. These expenses can easily be compensated for by economy in signalmen at a station of some importance; up to the present no advantage has been found in substituting fluid-operation for hand-operation in the case of stations of less importance.

The solution of this problem may however by sought by designers. It is only necessary to obtain an economical petrol motor and one capable of being easily maintained in working order.

So far as the signalmen are concerned, we may state that no difficulty has been found in respect to filling their ranks, nor in their apprenticeship : in most cases it has merely been necessary to select the more intelligent of the employees provided they were conversant with the traffic of the station which they had to work.

An apprenticeship of from two to four weeks according to the magnitude of the installation has been found amply sufficient to familiarise them with the operation of the appliances, since this is generally much more simple than that of mechanically operated appliances.

In England, the contractors have gerally been required to construct the operating levers of a form similar to those of the Saxby levers. The handles usually adopted in France and in Belgium appear more suitable to the end in view, and have given rise to no difficulty in respect to the apprenticeship of the staff.

Current Supply Installations. — In the case of hydraulic installations, accumulators fed by motor driven pumps are generally employed; in the case of compressed supply, air compressors are used; and in the case of electric supply, accumulators of the Planté type are the power used.

The storage varies according to the requirements of the case, but it is generally only small in those installations which do not use electricity as a motive power. In this case, provision is generally made against possibility of failure of the current supply plant by installing a duplicate plant. The electro-pneumatic system, moreover, allows of the use of an ordinary locomotive fitted with a compressed air brake in case of failure of the compressor.

The capacity of electric accumulators is generally so calculated as to allow for working the installation during two or three days without re-charging. This is a very valuable feature in our opinion, and one which greatly favours the introduction of electric installations.

SECTION *B*.

Precautions taken for preventing the premature change of position of points before they have been completely cleared by the train, whether the points are taken facing or taken trailing.

Prior to the use of bogie carriages for traffic on railways, the distance from centre to centre of the wheels of passenger vehicles did not exceed 5·50 metres (18 ft. $^{9}/_{16}$ in.). The use of mechanical arrangements for preventing the operation of a set of points during the working of the traffic or while a train was on that portion of the track, then presented no practical difficulty. These arrangements generally consisted of a bar of iron or steel arranged in advance of the point tongue and operated by the locking bolt of the points or by the point lever itself, when this latter lever effected the locking of the points. The section of these bars was T-shaped, or they were made of angle-iron; during the travel of the lever, the bar was raised, and afterwards fell to its normal position; this movement was prevented by the flange of the tyres when a wheel was near to the point tongue.

The locking bar was arranged either on the inside or on the outside of the track. These arrangements, commonly adopted, are too well known to warrant our giving more time to them. As a general rule they are only applied to points on main tracks taken facing, either by through traffic, or by shunting trains when the latter operations are controlled by fixed signals.

With the advent of the bogie carriage, which took place but a few years since, it has been necessary to make use of locking arrangements which, in order to be effective, must have a length at least equal to the distance between the centres of the inside wheels of these vehicles. At the present time this has attained as much as 10 and even 12 metres (32 ft. 10 in. and even 39 ft. 4 in.). It will be readily understood that the construction and operation of mechanical locking-bars of such length is extremely difficult. On the other hand, the necessity for placing such arrangements in the middle of the track, appliances at newly constructed passenger

stations, comprising scissors crossings, and cross-overs consisting of a succession of double slip points, greatly increases the difficulty of the problem.

Whereas in England mechanical locking bars are still used up to 10 and 11 metres (32 ft. 10 in. and 36 ft. 1 in.) in length, those Continental countries to which our questions were addressed, and in particular, certain French companies, and the Belgian State Railways, have attempted to solve the questions by means of electrical arrangements dependent on the use of insulated rails. This method consists in electrically insulating a section of track of sufficient length, situated in advance of the point tongues, and connecting it to an electric circuit comprising a battery and an electro-magnet, the armature of which is made to act either directly or indirectly on the lever actuating the points, or on the lever of its point lock. When a pair of wheels is on the insulated rail length, it puts this rail length to earth through the opposite rail, and the electric circuit is so arranged that the corresponding operating lever is locked by the armature of the locking electro-magnet.

It has not been possible to apply this simple and neat solution of the problem in England up to the present time.

The report of the special Commission of the *Block Signal and train Control Board* of the United States (1) gives the following reasons against the adoption of track circuits in England :

1° The very small weight of a considerable portion of the goods rolling stock;

2° The small use made of the brakes on goods wagons allows of the formation of a sort of varnish on the tyres which is of too low conductivity to enable the pressure of the wheel on the rail to short-circuit the relay;

3° The use of Mansell wheels with a non-conducting centre of wood;

4° The use of cast-iron wheels with steel tyres making a poor electric contact between the tyre and the wheel centre;

5° The cant of the rails corresponding to the coning of the rolling surface of the wheels;

6° The existence of a sort of skin or varnish which is a poor conductor of electricity on the heads of rails which are in work.

These reasons, which relate equally to the use of electric treadles consisting of insulated rail lengths, are not found on the Continent.

Several French companies adopt generally, in the case of points taken facing, the use of insulated rails for securing the points during the time of passage of the trains. The interlocking appliances act upon the operating levers in each of their extreme positions. They are actuated by means of a current normally flowing and interrupted by means of a contact actuated by foot. The French Northern Railway and the Paris-Lyons-Mediterranean Railway, however, do not use these appliances. The French State Railway uses an electric treadle fitted on the outside of the rail. When this treadle is pressed down under the weight of the wheels of the train, an electric current is sent to a relay placed in the signal cabin, and the electric

(1) " First annual report of the Block Signal and Train Control Board to the Interstate Commerce Commission ", *Bulletin of the Railway Congress*, Number of June, 1909, p. 483.

current which allows the operating lever to be unlocked, is interrupted.

In Italy, electric treadles are also not used, although the maximum distance between the wheel centres amounts to 11·319 metres (37 ft. 9 $^1/_2$ in.).

The Belgian State Railways generally employ electric treadles 15 metres (49 ft. 3 in.) in length fitted to points which are taken facing. We have given all particulars relating to these arrangements, in a note which appeared in the *Bulletin du Congrès des chemins de fer*, March 1910.

We have there shown that the only obstacle in the way of the general adoption of the new arrangement — the difficulty of insulating the points themselves — has been overcome in Belgium in the most complete manner.

A second method of locking the points, during the time a train is running over them, consists in interlocking them by means of appliances actuated by the trains themselves. In general principle, these arrangements consist of an electric or mechanical rail contact acting on a lever in the cabin in such manner as to lock it until the moment when it is touched by the wheels of the train; when this lever is thrown over, it itself locks the points of the corresponding route in the position which they should occupy. It would evidently be possible to use the signal lever itself for the same purpose, but this arrangement would have the serious disadvantage that it would prevent the setting back again to danger of the signal once it had been set to line clear and before the train had run over the complete route made. This has resulted in arranging the interlocking on a special lever and involves the use of auxiliary route levers.

In some cases, for example in the Saxby installations, a locking lever or even a point lever may be utilized for this purpose. Arrangements of this kind are still but little used except in Belgium, where it is required that every route more than 200 metres (218 yards) in length, not fitted with a signal at the end of the route, must be fitted with a treadle at the end of the route. This treadle consists of a rail contact, generally of the Siemens (mercury) type, used, in conjunction with an insulated rail, in such manner that the route is only cleared when it has been disengaged by the last wheels of the train. The circuit (fig. 49) comprises a battery of from 4 to 6 volts, a switch *c* operated by the route lever, the relay *r* coupled to the treadle P by the wire 1, and to the insulated rail by the wire 2; the circuit of the interlocking electro-magnet which is connected on the one side to the earth, and on the other side to the insulated rail by the wire 3; the wires 2 and 3 are normally disconnected by the switches *i* and i_1 operated by the armature of the relay *r*.

When the first pair of wheels of the train runs over the treadle P, a current excites the relay *r* which attract its armature and closes the switches *i* and i_1; so long as a pair of wheels occupies the insulated rail RI, the relay current flows through the wire 2, the insulated rail, the axle and earth, and the interlocking electro-magnet is short-circuited forming part of the circuit : earth, the electro-magnet *e*, the wire 3, the axle, earth.

When the last pair of wheels of the train has left the insulated rail, the current from the battery passes through the relay *r*, the wire 2, the insulated rail, the wire 3, the electro-magnet *e* and to earth:

the electro-magnet *e* is excited and, attracting its armature, frees the route lever.

This very complete and positive arrangement works perfectly. Except in the case of very important installations where numerous shunting operations have to be performed, it has enabled the use of locking treadles to be completely dispensed with. It is, therefore, very economical.

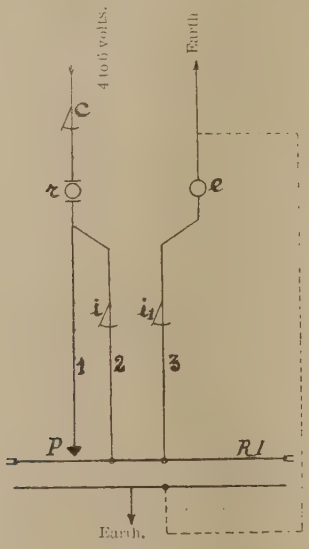

Fig. 49.

We think it is essential that arrangements should be fitted at the ends of routes, in all important installations consisting of long routes protected by a single signal, and particularly in those in which the points are fluid-operated. In these installations, in which no physical force is required for operating, the signalmen have a general tendency to throw back the signals to stop too quickly with a view to accelerating the traffic; they thus throw out of gear those interlocking arrangements which lock the point levers, so that these can be again operated before they have been run over by the train for which the route was made. In fluid-operated cabins particularly, where the operation of the points always takes two or three seconds at least, the train could enter the points while these were in motion, which would inevitably result in derailment. It is therefore essential to provide means for preventing this possible cause of accident.

SECTION C.

The use of a graphical method for facilitating the investigation of means of increasing the traffic on tracks serving passenger platforms, and the most important modifications required, affecting the tracks.

It follows from the particulars which have been supplied to us by those companies to whom we have sent the list of questions, that it is not customary to employ graphical methods for facilitating investigation of the best means of utilising the tracks serving passenger platforms.

Some companies occasionally use graphical methods on a time base for this purpose; these diagrams comprise as many horizontal lines as there are platform tracks, and are crossed by vertical lines corresponding to the twenty-four hours in the day, with intermediate divisions for every five minutes' interval. But this elementary method does not enable one to ascertain the possibility of effecting any particular movement of the stock at a particular moment in the day, without interfering with other traffic movements occurring at the same time; nor does it enable one to determine with certainty that a suggested time table is, or is not, workable with the arrangements existing in the station.

We have shown in the *Bulletin of the Railway Congress* (1) the graphical method, the adoption of which we suggested to the Belgian State Railway, applied by them to their large stations. This method which is at the same time very comprehensive and very simple, has been of great use in investigating the rational utilization of the passenger platform tracks, particularly at Antwerp Central and Brussels Northern stations. At the latter station, it has greatly contributed to the success of the final track arrangement brought into operation in 1907; it enabled this to be effected in a few hours at night, without causing any difficulty in the regularity of the train traffic. A note of this result was published in the *Bulletin of the Railway Congress* for September, 1907.

The Italian State Railways have also used the new Belgian graphical method for working out the arrangement of the large passenger station at Milan and have been extremely satisfied with the method.

CONCLUSIONS.

The reporters on question X have all drawn their conclusions independently of the work of their colleagues. Their schemes, therefore, only apply to those countries over which their investigations extended.

We have endeavoured to show, in the scheme which we are submitting, a general summary acceptable for all countries,

(1) « Note on diagrams used on the Belgian State Railway to facilitate the determination of the best utilization of platform lines at passenger stations », by L. Weissenbruch and J. Verdeyen (*Bulletin of the Railway Congress* of September, 1908, p. 933).

instead of one applicable alone to Britain, France, Italy and Belgium.

SECTION A.

The use of the fluid-operated central apparatus, principally for large stations, has made rapid progress during the last ten years. Such apparatus has the advantage of allowing of greater concentration, and, consequently, greater safety and greater rapidity of operation, while at the same time it renders more easy the work of the employees. It is also possible to obtain greater safety in working the traffic by arranging for the clearing of the routes by the train itself, by indicating the true position of the points, by obtaining the return to normal or stop position of signals after the train has passed (or in case of any disturbance in the route run over), etc.

The methods of power supply most usually employed, are on the one hand, electric current, and on the other hand, compressed air with electric indicating gear.

In the United States of America, where the latter system first came into most general use, electricity has taken the lead in latter years, and it is probable that it will continue to keep the lead over its competitors for the following reasons :

1° This system is more easy of adaptation and use;

2° The losses due to storage and in the distribution are very small;

3° The distribution and utilization of electric power are independant of variations of temperature or of severe extreme temperatures.

A similar tendency has been found in Europe.

In the case of isolated appliances, carbonic acid gas has been used with success.

In large stations to which an electrician is permanently attached, the concentration has led to a reduction in the number of signalmen. By this means, it has been possible to recoup the expenditure in capital while at the same time greater safety has been obtained than that which was formerly given by the old mechanical installations.

In France, trials are in progress with a view to operating all the points of a route by means of a single lever. The end in view is that of rendering more easy the apprenticeship of the signalmen.

In Germany and in Belgium, attempts to operate points simultaneously, other than those usually worked in combination for a cross-over, have been given up. In those countries, it is thought that the apprenticeship of the signalmen can always be effected quickly if they are familiar with the traffic at the station and that apprenticeship in quite useless unless they are familiar with the traffic.

Up to the present, the central electric installations have been operated by continuous current. Single phase alternating current and three-phase current have also been tried. Up to the present the following difficulties have been met with : difficulties of insulation, increased cost of the motor and of the electro-magnets, noise made by the motors when stopped, risk to the staff, and the impossibility of dispensing with accumulator storage.

Section *B*.

1° Mechanical and electrical appliances are in use for locking the points during the period while they are being run over by the trains. These arrangements, which should have a length at least equal to that of the greatest distance between the wheel centres of vehicles in use on the railway system, are not generally applied except in the case of points taken facing.

There is a tendency on the continent to gradually substitute electric treadles for mechanical treadles.

2° Electric treadles are generally worked by means of a normally flowing current interrupted by means of a foot-operated economiser switch; by this means the difficulty of insulation of the points can be easily overcome.

3° The arrangements at the end of a route, acting only after the last wheels have passed, enable all the points on a route to be interlocked up to the moment at which the train has entirely cleared the route. The use of these arrangements may be substituded for a series of locking bars at the points with economy.

Section *C*.

The use of a graphical method enabling the investigation of the best utilization of tracks serving passenger platforms may be of very great service, particularly in the case of modification of the track arrangement.

The method used by the Belgian State Railway in particular affords a general and complete solution of this problem.

SECTIONAL DISCUSSION

Meeting held on 9 July 1910 (morning).

MR. DIETLER, IN THE CHAIR.

The President. (In French.) — We now begin the discussion of question X. I call upon Mr. Verdeyen, reporter for Great Britain and colonies, Belgium, France and Italy.

Mr. Verdeyen, *reporter.* (In French.) — The question of the operation of switches includes three very distinct sections. I propose that the discussion should be divided and that we should not pass to littera *B* and littera *C* until the discussion of the first section, littera *A*, has been completed.

Mr. Dufour, *reporter.* (In French.) — In my opinion it is preferable that the reporters should first give summaries of their reports and that the three sections of the question should then be discussed separately.

Mr. Ulbricht, *reporter.* (In German.) — I agree with this proposal.

The President. (In French). — I call upon Mr. Dufour to give us his summary.

Mr. Dufour, *reporter.* (In French.) — I have been entrusted with drawing up a report on question X, as far as Holland is concerned.

The railway system of my country is rather a limited one, if compared with that of other countries with a similar density of population, owing to the numerous waterways which intersect it in all directions and which connect all the large towns and nearly all the villages.

The receipts which our railways obtain from passenger traffic are nearly the same as in adjoining countries; as regards goods traffic, they amount to as much per kilometre as those for passenger traffic but nevertheless, owing to the waterways, they are much less than in adjoining countries.

It is hence natural that the sums available for putting in safety appliances in Holland should not be very high, and we must limit ourselves to putting in such appliances successively on the important lines.

The railways in Holland are built partly by the State and partly by private companies, and they are operated by two companies which have about 1,500 and 1,800 kilometres (about 930 and 1,120 miles) of line respectively, and also by two other minor companies.

*

In order to make the large towns benefit by the competition of the two chief companies for the traffic to the ports and to the frontier, the State has imposed on some lines " rights of way ", by virtue of which complete trains of one company have the right of running over the lines operated by the other company.

As the Permanent Commission had appointed me as reporter for Holland only, and as I belong to the one company, I directly obtained from the other the information necessary and I drew up my report without having to send out a detailed list of questions.

My report contains to some extent a history of safety appliances in Holland, and the results of the experiments on which our signalling systems are based.

Littera *A*.

Only double-wire apparatus have been put in since 1883. The principles of construction adopted at that time have been retained since.

As a rule only semaphore signals are used, both for the main signals as well as for the distant signals. The latter have an arm cut square which when inclined at 45° downwards (or shows a green light at night) indicates slacking, while when inclined at 45° upwards (a white light at night) it gives " lines clear ".

On the lines of the Dutch State, the signals located between the outermost points are operated both for trains as well as for shunting operations. At new installations the general principle has been adopted of having a system of signals which extend to all the sections of the cabins, run over by trains or during shunting operations.

On the lines of the Dutch Railway this system has not been adopted, but special signals for shunting operations are used very extensively.

Fixed optical indicators, called " beacons ", are place by the track, at a distance of about 850 metres (930 yards) from the main signal, in order to warn the trains that they are approaching signals, if the weather is rather foggy.

The distance between the distant signals and the main signals, and that between the signals and the outermost points are not very great, for special precautions are taken in times of thick fog (telephonic and telegraphic messages, giving the position of the signals). These messages are sent to the previous cabin and there detonators are placed on the track. The distance between the two signals is only 450 metres (492 yards), and that between the main signals and the outermost points is 100 to 150 metres (109 to 164 yards).

The points and signals of small stations on single-track railways are centralized in a frame near the booking office, while two cabines are placed at the ends of double-track sections. Most of these cabines also attend to the level crossings.

Siemens & Halske block apparatus are used everywhere on the open line, and also for interlocking the signals placed at a distance from stations.

The frames used are of three types. The first type, very simple and very strong, having six locking bars, can be put up in the open air, but its construction does not make electric interlocking possible. It suffices for simple installations and seldom have used with hardly more than ten levers. In the case of other installations, Siemens & Halskelever apparatus or si-

milar apparatus are used, of the Dutch Railway Company's type.

The appliances for operating and locking the points have for some time been made so that the switch can be forced open from the trailing side; in the case of junctions and other parts of the track where shunting operations are not carried out, switches which can not be forced open are retained. Locking clamps are not used; the locking is effected by a thrust. The switches on the Dutch State Railway are only provided with signals exceptionally.

The semaphore signals consist of conical tubes made of steel plate; more recently Mannesmann steel tubes are used. The arm of distant signals is made of aluminium, so as to be lighter. In the lanterns, the nickel reflectors have been replaced by Fresnel glass lenses, which are supplied by an American firm. These lenses are cheaper and concentrate the light better. Where several signals are close together and when conditions are suitable, electric light is used.

On the return sheaves, rope is not used, but strong chains, attached to hooks soldered to the wires. In several cases return sheaves have been successfully replaced by wires laid in gas barrels curved to a large radius and filled with heavy tar oil.

Oscillating compensating gear, of a system not well known, is only used in rare cases. Most of the points taken from the facing side by fast trains are locked.

In order to make the position of a signal dependent on two or three cabins, very simple slot gear is frequently used, acting on the wire line.

Of late years, the Dutch railways have followed the example of neighbouring countries and have installed several centralized frames. These can only be used to a limited extent, as the zone of action of the cabins can hardly be more extended with power operation than with the double-wire system. The advantages found are as follows : the employees have to use less force and the apparatus are permanently controlled. It is a question whether these advantages will justify the greater cost.

Stahmer apparatusr, operated pneumatically and controlled electrically, and also purely electrical apparatus have been installed. The cabin apparatus are in both cases exactly the same. I think that the choice between these two systems is merely a matter of price or a matter of taste.

Both systems, as compared with each other, have sundry advantages and disadvantages.

Although I think that the cost of mainnance of power-operated installations is somewhat lower than that of hand-operated installations, the original cost is 30 to 50 per cent higher, not including the cost of the power supply.

Littera *B*.

The search for a simple and effective arrangement for preventing the premature shifting of points is one of the most important questions which have to be solved. A mechanical solution becomes more and more difficult because the distance between the axles of carriages is being increased, and the points at large stations are becoming more and more entangled.

The application of insulated rails has the disadvantage that wooden fishplates and electric connections have to be introduced into the steel track; moreover it has to be noted that good insulation can more easily be obtained where the lines are ballasted with good broken stone, than when muddy sand is used, as in Holland.

The mechanical system and the electric system are used in Holland. Mechanical treadles from 7 to 11 metres (from 23 to 36 feet) long and placed inside or outside the track are used with many switches. They are used generally in the case of the switches of small stations, operated from the platform; in the case of cabins where the work is performed by employees accustomed to operating switches, their use is limited; there electrical arrangements are sometimes adopted. We have now had in use for some time locking treadles in connection with switches, whose points rise from the bedplates instead of sliding on them. The raised point serves, over part of its length, as a prolongation of the treadle.

Nevertheless, I think that in the future electric devices will become used more and more.

Considering question X from the point of view of Holland, I have come to the following conclusions :

Littera *A*. — *Improved centralized installations for operating switches and signals. The use of water, of compressed air, of electricity, for working the transmissions. Electric interlocking. Route levers.*

The safety appliances in the Netherlands resemble in many respects the types of appliances in use in Germany and in Austria. The semaphore with arms takes the place of the disk signal used in those countries in the case of the distant signal.

For operating the points and the signals, double steel wire transmission has been exclusively in use for the last thirty years. These transmissions, which extend up to 550 metres (600 yards) for points, and up to 1,100 metres (1,200 yards) for signals, are only fitted with compensating gear under exceptional circumstances.

The distant signals are constructed in such a manner as to fall to danger in case of breakage of the wire. No arrangements have been adopted for locking the points in case of breakage of the wire.

The outermost points, worked at a distance of more than 250 metres (275 yards) are bolted. One of the two companies, the company for working the Netherlands State Railways, has extended the use of bolt-locks to the greater number of the important point-tongues, where these are taken facing by express trains. Many points are fitted with operating gear permitting them to be run through trailing when wrongly set.

The safety appliances, with the exception of the interlocking of the points, consist in general in that the signals cannot be set to " line clear " except with the mutual consent of two cabins. The use of signals with superposed arms showing the route is only adopted to a limited extent on the lines of the company for working the Netherlands State Railways. The drivers find a point signal slightly raised at the outer points of small stations for giving the direction at places where trains pass without stopping.

The Holland Railway Company, by adopting candelabra semaphores in several stations, has attempted to show the drivers the route which they are to take.

The company for working the Netherlands State Railways has adopted the use of the same signals for the trains and for shunting operations inside the stations, whereas the

signals of the Holland Railway Company apply only to trains in transit.

The company for working the Netherlands State Railways has adopted a system of line normally blocked on its main line, whereas the Holland Railway Company has adopted the block-system with line normally clear.

Centralised appliances for working points and signals depending on the use of compressed air or electricity as motive power, can be applied with success to large stations. These appliances have the advantage that they require no physical effort from the staff.

The degree of safety obtained with these appliances is greater than that obtained by hand-lever gear, because it is possible to have a permanent indication in the cabin of the position of the point-tongues and of the signals.

The Stahmer electro-pneumatic appliances have not shown the disadvantages which have often been attributed to them. It must be stated that the maintenance of tightness of the piping, and that condensation from moist air have not given rise to trouble.

The electro-pneumatic appliances can be applied without the addition of special mechanism to point-tongues consisting of flexible rail, in order to permit of the points being run through trailing when wrongly set.

The cost of electro-pneumatic installations and of entirely electrical installations is, exclusive of the cost of supply of energy, higher than that of the double-wire mechanical installations, although there are cases in which the costs differ little.

The cost of the electro-pneumatic installations is, for a small number of levers, much greater than that of the entirely electric installations. For installations of small size and of great extent it is necessary to work out the cost for each particular case.

The cost can be diminished by constructing the operating mechanism for the points and signals in large quantities of the same dimensions, by means of special machinery, and in a factory equipped for this purpose, as in the case of bicycles and sewing machines. It would be well to unite the appliances for operating and those for locking the point-tongues in a single appliance which could be fixed without difficulty to all points.

It is possible that in operating signals, the solenoid has some advantages. It has to be noted that even though the efficiency of the solenoid is less than that of the rotating motor, the question of efficiency is of no great importance, because the energy required for operating is only a small portion of the total energy required including that necessary for the indicator.

Littera *B.* — *Arrangements adopted to prevent switches taken from the facing or the trailing side from changing their position before the whole train has passed.*

It is possible to construct mechanical treadles (locking-bars) for separate points operated by the double-wire, which, when well maintained, can give satisfaction for a distance of 7 metres (23 feet) between consecutive wheel centres. In combining these treadles with points fitted with point-tongues which lift in their to and fro movement, the distance between consecutive wheel centres may attain 11 metres (36 feet).

If the distances at which the appliances are operated are not great, mechanical treadles 11 metres (36 feet) in length, can be operated with the points. These treadles have disadvantages in case the points are taken trailing when wrongly set.

For the numerous arrangements of points which are found in a large station, the use of separate treadles is almost impossible. It is necessary to have recourse to the bolting of routes. This bolting is unlocked after the passage of the train, either by the following cabin, or by a block-apparatus at the cabin itself, which can only be unblocked on condition that the train has passed a certain place.

These combinations usually apply only to

the regular trains; the shifting of a set of points under a train during shunting is not prevented.

It appears to be of importance that efficient forms of construction should be found, which may be applied to points whatever may be their situation, and which may apply to vehicles having successive axles at a great distance from each other, both for trains and for shunting operations and without causing delay where the traffic is congested.

Gentlemen, such are the summary and the conclusions of my report. As I stated at the start, this report is not the result of a detailed list of questions and my conclusions apply to a very limited field. They cannot be drawn up in such a categorical way as those which result from the answers of a large number of administrations, as in the case of the other reporters.

Although I am very ready to answer any questions I may be asked, I propose to you not to start discussing the conclusions I have read out. I think it would be better to discuss the conclusions in Mr. Ulbricht's paper which are drawn up more concisely, and which are the result of inquiries addressed to thirty administrations.

We could also discuss the conclusions certained in Messrs. Weissenbruch and Verdeyen's report.

The President. (In German.) — I request the second reporter, our vice-president, Mr. Ulbricht, to give us a concise summary of his report.

Mr. Ulbricht, *reporter*. (In German). — Owing to the vast extent of the territories covered by my report — there were twenty-seven administration located in the following countries : Germany, Luxemburg, Austria, Hungary, Rumania, Denmark, Bulgaria, Russia, Sweden, Switzerland, Servia, Turkey and Norway — I have thought it better, instead of going in for long details about construction, to try to give a general report of the state of the appliances we are considering. With this object in view, it seemed to me necessary to divide the first section of the question namely : littera *A* : *Improved centralized installations for operating switches and signals. The use of water, of compressed air, of electricity, for working the transmissions. Electric interlocking. Route levers*, into four parts; that is a classification which might also be adopted in the discussion.

I have divided this first section as follows : centralized hand-operated apparatus, that is to say, central frames by means of which apparatus at a distance are operated by manual power; then come central apparatus with power operation, in which the operation is carried out by means of some power; then comes a chapter on switches and signals generally; and finally there is a chapter about the electric interlocking of route levers.

My verbal summary can be very concise. It is impossible, in fact, to enter into the details of so comprehensive a subject, and you will allow me to refer you to my printed report. I shall be satisfied with drawing your attention to several points which are perhaps particularly suitable for discussion and may give rise to more ample commentary.

In the chapter relating to hand-operated apparatus, a particularly important question, considered in detail in my report, is that of knowing whether rodding or wire transmissions are to be preferred for operating signals.

Another question of great interest is the arrangement of cuttable locks, which I will not refer to further now. Then comes the question of the advisability of using the central frames for locking the switches, not for operating them, independently of the cases where the locking is simply added to the operation and serves as a control. The results of the inquiry differ as regards this system of locking at a distance from the switch. Some administrations adopt it on the large scale. But I have recognized that, taking it altogether, such locking of switches is only applied to a limited extent.

As regards the operation of signals, it is hardly necessary to say that double-wire transmission has assumed paramount importance. Allow me to read to you the final remarks made in my chapter dealing with hand-operated apparatus; they are as follows :

Important improvements in hand-operated apparatus are not in prospect for the moment. However, there is no doubt that further improvements will be made in the combination of electrical and mechanical devices, and it is to be expected that in this way many difficulties, which at present have arisen in the case of purely-mechanical treatment, will be overcome very satisfactorily. Thus the question of safety in the case of the fracture of a wire, is one which is very probably soluble by electrical methods. Then also it may be expected that the development of power operated installations will stimulate, in more than one direction, the design of hand-operated installations; for at present there is no question of replacing hand operation by power operation in the majority of cases, and attempts will be made to adapt part of the improvements in power operation also in the case of hand-operated installations.

The second chapter, dealing with central apparatus with power operation, is chiefly devoted to the comparison of the two systems of electrically-operated and electro-pneumatically-operated apparatus. You will find in my report the opinions of the different administrations relating to this subject; it shows that for the moment most of them are in favour of electric operation, which is already applied very extensively in the countries with which my report deals. You will see that the electrically operated systems of Siemens & Halske and of Jüdel & Co. are now represented in Germany by 243 installations, with 6,907 switch motors and 1,824 signal motors; in Austria, by 22 installations with 411 switch motors and 224 signal motors; in Denmark, by 8 installations with 77 switch motors and 7 signal motors; In Russia, by 3 installations with 40 switch motors and 9 signal motors.

On the other hand, in the same countries, there are 10 installations, with 1,135 levers, using compressed air, on the most usual system, namely the Westinghouse, represented by the firm Stahmer, of Georgsmarienhütte.

That is already a very notable extension of the use of apparatus with motors, and these figures show that this is a question of system to which great attention should be devoted.

What is of particular importance with these central apparatus with motors, is the question of knowing how much maintenance is required, whether many failures are to be expected, and what are the economic results.

As regards failures, I may mention that although as a rule a greater number of

failures has been observed with central apparatus with motors, it is as a rule easier to set them right than in the case of hand-operated apparatus. Here again I may be allowed to read the conclusion in my report, which runs as follows :

A saving in the staff, in the case of power operation is not everywhere effected, but as a rule there may probably be a saving of 20 to 33 per cent, as Alsace-Lorraine, Wurtemberg, Hungary and the Russian State Railway recognize. Prussia states that it depends on local conditions, whether and what saving in the staff can be effected.

Accordingly opinions also differ, as to what economical advantages there are. These are also affected by the occasionally high cost of maintenance, and by the interest charges on the considerable outlay required; the general experience up to date does not show that these are so marked as to form a strong argument in favour of the future extension of power operation. In Austria-Hungary however, economic advantages have resulted both as regards staff and as regards maintenance.

The question of the economic advantages is however in this case also not the only deciding one; the most important point at places with much traffic is to have such arrangement that the staff can, without being overworked, work the service smoothly, quickly and safely. All the administrations which have up to the present used power installations agree that they make it easier to work the service; this is a sufficiently-great advantage to make it certain that power installations will be used in future, in spite of sundry existing minor defects. Therefore those administrations also which have already tried power installations in cases of much traffic, are considering the further extension of power operation in the case of installations at large stations particularly as there is no doubt that progress will be made and such devices will become more and more reliable. Electric operation by motors in such cases receives much more attention than other systems. The administration of the Prussian State Railway, which alone has a considerable number of experimental electro-pneumatic installations in use, states that the comparative trials are not yet completed.

As regards switches and signals generally, the illuminating power necessary for the signal lanterns has been considered, and then the appliances for enabling the train to set the signal to " danger ", appliances which of late have been recognized to have many advantages and which have been adopted in many cases; finally also a particular evolution of central apparatus acting directly at the limits of their zone of influence on the cabs of drivers, I mean cab signals. I will read from my report a few remarks about this subject, for I think this is precisely a point which we might discuss :

Then also many inventors have for tens of years aimed at making a warning signal appear or sound in the locomotive cab when the train approaches a main signal standing at " danger ". But only a few of the devices proposed have proved at all promising. In the countries we are considering, matters in this respect have as yet only reached the experimental stage. The chief difficulty is that the electric-contact devices for conducting the current from the line to the locomotive (such as the Lartigue " crocodile " contacts) cannot be depended on to act satisfactorily under unfavourable climatic conditions, as extended trials made by the Saxon State Railway on a line in the Erzgebirge have shown; and that mechanical devises are not only very liable to destruction in consequence of the high speed of trains, but also exercise a bad influence on the reliable working of the distant signal, if connected with it. Nevertheless, several experiments have recently

been begun in Germany with the van Braam signalling system, in which a treadle on the line acting on a sensitive lever with a transmission to the cab, fitted to the locomotive, operates a powerful signal, records the operation and if required also applies the continuous brakes. The latter seems at first sight a desirable action from the point of view of safety; but weighty objections have been raised against it.

Attempts are also made to obtain a certain amount of protection against the overrunning of signals by having every case of over-running, even if it has not been attended by any detrimental consequences, recorded by an automatic recording gear; and the driver is afterwards held responsible.

Among the general applications of central apparatus, an important place is also occupied by communications within the limits of the zones of action of central apparatus in the case of sorting operations. Conjointly with this, we have described attempts made to introduce a system of automatic sorting, a system in which any communication within the zone is required less than in the usual practice. At the end of this chapter, I make the following remarks in my report :

Very good results have been given, in the case of a shunting service, in order to communicate between the top of the inclines and the switches at the corresponding sorting sidings, by loud-speaking telephones as well as by electric track indicators, which are constructed on the pattern of needle telegraphs. Track indicators which have incandescent lamps lighting up behind transparent number plates, have also been used with advantage.

Mechanical needle instruments with a wire transmission have also been used instead of the electrical instruments. In many cases however, for instance in Switzerland, the siding numbers are only written on the buffers of the descending wagons; in Bavaria, numbered plates are hung on the buffers.

Newer installations and arrangements are devised with the object of making it unnecessary to given individual indications in the case of each descending wagon as in accordance with American practice the order of sequence of the different sidings on to which the wagons are to run is laid down in advance in writing, so that the switches can be set in succession in accordance with this list. A further step in advance is the use of power installations to carry out the sorting operations required; in the system devised by Messrs. Siemens & Halske, a paper band, perforated to correspond to the list, regulates the sorting automatically.

No further improvements in connection with switching and signalling appliances are contemplated by the different administrations.

I will say but a few words about the electric interlocking of route levers. The report I submit makes a special mention of the kind of current to be used (direct current) and of how the interlocking is effected, either by rail contacts acted on by the train, or by the train manager at the station, by means of an electric current.

Finally I say a word, in my report, about group-blocking, used on different railways and in various forms; I will not refer to this now. This chapter concludes with the following remark :

In the cases in which sufficient experience is available, the electrical route-interlocking has without exception given favourable results. There is no expression of opinion in its disfavour even in cases of much traffic. Several administrations also speak in favour

of mechanical route-interlocking. It is however to be noted that Prussia does not intend to use mechanical interlocking in future. Electrical route-interlocking is also strongly recommended in the case of new installations; in some cases, attention is also drawn to the fact that under certain circumstances mechanical interlocking may be also advisable.

Such are the four chapters of littera *A* of question X.

Then comes littera *B*: *Measures employed for preventing the premature operation of switches.* Here we have in the first place to note the length found practical for these appliances.

As a rule it is 10 to 12 metres (32 ft. 10 in. to 39 ft. 4 in.), and attains 13·50 metres (44 ft. 3 $^1/_2$ in.) in Saxony and 16 metres (49 ft. 3 in.) in Wurtemberg. Then I have to mention the use of electric block apparatus, conjointly with insulated rails and rail contacts, which involved a detailed examination of insulated rails and of the construction of the insulating joint.

Finally you will find in my report a discussion about rail contacts, with special reference to the recent type of drop contacts. This chapter concludes as follows:

No particular difficulties in the service or in maintenance have arisen from the use of these safety appliances for preventing the premature operation of switches. The general opinion on the contrary is that they have a favourable influence on the carrying out of the service.

Finally the report mentions the graphic representation of the utilization of platform tracks. As regards this point, I have not obtained much information. Many administrations use such graphic representations, and that with satisfactory results. I may remark that such graphics apply not only for the utilization of platform tracks, but can also be used for other tracks and are particularly convenient when train time-tables are to be modified.

This is my final remark:

The graphic representations of the occupation of the track, mentioned above, are by no means limited to platform tracks; they are also frequently extended, in so far as they are used at all, to other entrance and departure tracks. This applies especially if we also include among them the marks appearing in in the case of electric unlocking appliances. With this extended meaning attached, it also applies in some cases to locomotives running light, while graphic representations proper, of the track, are not used in these cases and in the case of shunting operations.

The arrangements mentioned are stated to give good results both as regards the facilitation of the service and as regards safety. The use of graphic representations has proved especially valuable when special trains have to be intercalated.

In organizing the train service at a large station, as far as the point of view of safety is concerned, the importance of such graphic representations is small as compared with the further development of electrical checking devices and means of communication, which make it possible for the different apparatus to work separately and yet form one united whole from the point of view of safety.

I have not given you any conclusions proper; I preferred, at the end of my report, to enunciate forty-three propositions, forming a summary of the chief results. But I do not consider it impossible to take these propositions, or at least those which meet your approval, as basis of a resolution, declaring that the section agrees with this summary of the results of the

report. It will of course be for you to decide whether you will proceed in this way. But if so, I would now already remark that I have made a small addition to article 25, which I will mention when the different articles are discussed.

In conclusion I may add that one of the administrations concerned only sent me its answers a week ago; namely that of the Norwegian State Railway; hence it was impossible for me to utilize this information in my report. At the beginning of this meeting, I have just received a letter from the Swedish State Railway, giving supplementary information relating to question 16 in the list of questions; when the time has come, I will submit this to the section.

The President. (In German.) — As Mr. Carter is not present, I call upon Mr. Verdeyen.

Mr. Verdeyen, *reporter*. — Mr. Weissenbruch, whose duties as general secretary prevent him from being present at the beginning of this meeting, has asked me to make his apologies.

LITTERA A.

Gentlemen, in our report we have only considered installations for operating switches and signals by power transmission. It was in fact only starting from the time that the signalman had no longer to use the power of his arms, when what is called power signaling was instituted, that real improvements could be introduced into the operation of switches and signals.

Our report includes in the first place a summary description of all the operating systems in use in the different countries to which our inquiries extended.

The investigation has led to the following general considerations :

The operation of switches and signals *at a distance* is effected by means of water under pressure, compressed air and electricity. With water under pressure and compressed air, motors with pistons are used, the reciprocating movement of which can be transmitted direct to the switches or signals, while with electricity solenoids have for various reasons as a rule been given up, and motors are used and their rotation is converted into rectilinear movement by means of gearing, by spur wheels and racks. But this apparent advantage of water under pressure and of compressed air is largely counterbalanced by the disadvantages inherent in those two methods of transmitting power. These disadvantages are the leakage at the joints and at the packings of the pistons, the difficulties of replacing one motor by another in case of a break-down, or when the maintenance of these appliances has to be attended to; and as regards more especially water under pressure, the care required during winter to prevent freezing.

Our American colleague, Mr. Carter, moreover states that in his country, where are many applications of compressed air, electricity now offers the greatest advantages.

As regards the control of the track appliances, it is considered indispensable, in the case of power installations, to have a device in the cabin for showing the positions of the appliances which are at a distance. This control can be operated by means of compressed air, of water under pressure or of electricity. But compressed air and water under pressure have certain disadvantages, particularly as

regards the time required before the checking operation is completed. This in the case of compressed air may take as long as twenty seconds, and in that of water under pressure from ten to twelve seconds; in the case of electricity, on the contrary, the checking is instantaneous, and this method is also the cheapest. The *French Northern Railway Company* is trying a new system, known as the M. D. M. system, in which there is a hydraulic control which works relatively quickly.

An objection which might be raised against the electric control, is that wrong indications might be given if the wires became entangled or if the conductors became faulty. Hence it is necessary to establish the electric circuit in such a way that a wrong indication can never be given; and this is a point which certain designers sometimes seem to forget.

In this respect, the Siemens & Halske system and the Siemens Brothers system have the great advantage, as compared with all other systems in which an electric control is used, of entirely eliminating the risk of a wrong indication should the wires become crossed.

There are two kinds of electric control to be considered : the permanent control and the momentary control. The latter only acts at the moment the movement of the apparatus operated is completed and ceases immediately after the second stage of the movement of the lever has been carried out. As regards the permanent control, this starts acting and remains in action as long as the appliance at a distance is in a position corresponding to that of the lever operating it.

The first system accordingly has the disadvantage of making it necessary to divide the operation of the lever into two stages, so as only to release the mechanical interlocking after the actual indication that the operation is completed has been received.

On the Paris Ceinture line, where the Taylor system has been installed as an experiment, with its " absolute " system of control, the railway company has required the addition of a permanent control.

As regards the operation of signals, it has to be noted that both in France and in England, as a rule, the single-action system has been retained, the signal being returned to the " danger " position by gravity.

In Belgium, on the contrary, we have a system which enables us to move the signal in both directions. Moreover, between the signal and the operating apparatus, there is an electric device which with this double-acting system obtains a degree of safety similar to that obtained in the case of mechanical double-wire transmissions, the signals being automatically set to danger should a wire break.

As regards central apparatus, the systems used in the countries considered in our report generally include individual operating levers for operating the points and signals. In France, different railways have applied the systems known as " route-lever " systems, in which all the switches and signals of one route are operated by a single lever.

These appliances are comparatively new and we do not think that this practice is as yet well established.

In our report, we have examined these installations, more especially from the point of view of the time the signalmen

take to become acquainted with it, the staff and time saved, the ease of maintenance, etc.

These considerations show, in our opinion, that the system of individual operation is of equal value, if not preferable, from all the points of view, to the system of operation by means of route levers. We think that this point will attract the attention of the section during the discussion.

The failures which occur in the case of fluid-operated installations for working switches and signals are few in number and of minor importance.

In the hydraulically and pneumatically operated cabins, leakages have been the most frequent trouble, especially at the joints of the pipes and at the packings of the pistons. In the cabins operated electrically, there are failures of contacts, slacking of terminals, damage to cables, blowing of fuses, failure of indication due to the presence of foreign matter in the points, etc.

Now, as Mr. Ulbricht has remarked in his report, most of these failures are not due to the use of electricity, but to defects in the track and the switches, of which the electrical appliances give valuable indications

As regards first cost, this varies greatly with different installations, and it would be difficult to make any comparison.

In our report we have compared the Saxby installations such as they exist in Belgium, with the Siemens & Halske apparatus used at Alost.

The operation of all the signals and switches, which cover a length of about 1,200 metres (1,312 yards), is concentrated in a single cabin crossing the track, fitted with an electric installation on the Siemens & Halske system.

To operate these appliances by hand would have required the construction of four cabins and would have involved an expenditure of about 400,000 francs (£16,000). The electric installation has involved an expenditure of 440,000 francs (£17,600). The extra capital expenditure was hence only 40,000 francs (£1,600), but this will be saved after nineteen months of working. For the working expenses would have amounted to about 48,000 francs (£1,920) per year in the case of manual operation, while they became reduced to 22,000 francs (£880) in the case of electric operation. There is consequently an annual saving of 26,000 francs (£1,040) or 2,166 francs (£86.13 *s.*) per month ; and of 41,154 francs (£1,646.3 *s.*) in nineteen months.

The current-supply installations are generally accumulators fed by motor-driven pumps in the case of hydraulic installations; in the case of compressed air, air compressors are used; and in the case of electricity, accumulators of the Planté type.

Here again we find the advantage of electric accumulators in the fact that they can be arranged so as to allow for working the installation during two or three days without recharging.

Littera *B.*

The question of treadles has given rise to much trouble since bogie carriages have been started running on railways. Formerly the treadles or locking bars only had to be 5·50 to 6 metres (18 ft. $^1/_2$ in. to 19 ft. 8 in.) in length, while now the

length must to be 10 to 12 metres (32 ft. 10 in. to 39 ft. 4 in.); on the lines of the Belgian State Railway we have even adopted a length of 15 metres (49 ft. 3 in.), with an eye to the future.

The construction and the operation of mechanical treadles of such length are difficult and expensive. Accordingly, in most countries, mechanical treadles are generally being replaced by electric treadles.

There is a second method which makes it possible to keep the switch immovable during the passage of the trains; this consists in locking it by means of devices operated by the trains themselves. This electric or mechanical device is in this case placed on the track, and acts on a lever in the cabin, so as to make it immovable until it is moved by the wheels of the train; this lever in its thrown-over position locks the switches of the corresponding routes in the position which they should occupy.

This second method is yet but little used, except in Belgium, where it is prescribed that every route more than 200 metres (219 yards) in length, not fitted with a signal at the end of the route, must by fitted with a treadle at the end of the route.

Littera *C*.

The information supplied to us shows that until now graphical methods for facilitating investigation of the best means of utilizing the platform tracks of passenger stations are seldom used.

The Belgian State Railway has adopted a graphical method which consists, taking it altogether, in applying to the stations the graphical time-tables used for the trains.

This method has given goods results and the Italian State Railway, which has applied it at Milan station, has been very satisfied with it.

The following are the conclusions which we have the honour to propose to you, conjointly with our colleague Dr. Ulbricht :

Littera *A*. — The use of the fluid-operated central apparatus, principally for large stations, has made rapid progress during the last ten years. Such apparatus has the advantage of allowing of greater concentration, and, consequently, greater safety and greater rapidity of operation, while at the same time it renders more easy the work of the employees. It is also possible to obtain greater safety in working the traffic by arranging for the clearing of the routes by the train itself, by indicating the true position of the points, by obtaining the return to normal or stop position of signals after the train has passed (or in case of any disturbance in the route run over), etc.

The methods of power supply most usually employed, are on the one hand, electric current, and on the other hand, compressed air with electric indicating gear.

In the United States of America, where the latter system first came into most general use, electricity has taken the lead in latter years, and it is probable that it will continue to keep the lead over its competitors for the following reasons :

1° This system is more easy of adaptation and use;

2° The losses due to storage and in the distribution are very small;

3° The distribution and utilization of electric power are independent of variations of temperature or of severe extreme temperatures.

In Europe, electrically-operated installations are the most used form among power-operated installations.

In the case of isolated appliances, carbonic acid gas has been used.

In large stations to which an electrician is permanently attached, the concentration has led to a reduction in the number of signalmen. By this means, it has been possible to recoup the expenditure in capital while at the same time greater safety has been obtained than that which was formerly given by the old mechanical installations.

In France, trials are in progress with a view to operating all the points of a route by means of a single lever. The end in view is that of rendering more easy the apprenticeship of the signalmen.

In Germany and in Belgium, attempts to operate points simultaneously, other than those usually worked in combination for a cross-over, have been given up. In those countries, it is thought that the apprenticeship of the signalmen can always be effected quickly if they are familiar with the traffic at the station and that apprenticeship in quite useless unless they are familiar with the traffic.

Up to the present, the central electric installations have been opperated by continuous current. Single phase alternating current and three-phase current have also been tried. Up to the present the following difficulties have been met with : difficulties of insulation, increased cost of the motor and of the electro-magnets, noise made by the motors when stopped, risk to the staff, and the impossibility of dispensing with accumulator storage.

Littera *B*. — 1° Mechanical and electrical appliances are in use for locking the points during the period while they are being run over by the trains. These arrangements, which should have a length at least equal to that of the greatest distance between the wheel centres of vehicles in use on the railways system, are not generally applied except in the case of points taken facing.

There is a tendency on the continent to gradually substitute electric treadles for mechanical treadles;

2° Electric treadles are generally worked by means of a normally flowing current interrupted by means of a foot-operated economiser switch; by this means the difficulty of insulation of the points can be easily overcome;

3° The arrangements at the end of a route, acting only after the last wheels have passed, enable all the points on a route to be interlocked up to the moment at which the train has entirely cleared the route. The use of these arrangements may be substituted for a series of locking bars at the points with economy.

Littera *C*. — The use of a graphical method enabling the investigation of the best utilisation of tracks serving passenger platforms may be of very great service, particularly in the case of modification of the track arrangement.

The method used by the Belgian State Railway in particular affords a general and complete solution of this problem.

The President. (In German.) — Gentlemen, now that you have heard the reporters, I will open the general discussion. It has been proposed to adopt the same subdivision as in the wording of the question. The reporters have declared that they agree herewith.

I will accordingly read out the question again. Littera *A* runs as follows : " Improved centralized installations for operating switches and signals. The use of water, of compressed air, of electricity, for working the transmissions. Electric interlocking. Route levers."

Thus section A includes all that refers to central apparatus operated by hand, as also central apparatus generally.

As regards littera *B*, we then will have to consider : " Arrangements adopted to prevent switches taken from the facing or the trailing side from changing their position before the whole train has passed " and as regards littera *C*: " Use of diagrams to facilitate the consideration of the full utilization of tracks along passenger platforms and the modifications to be made, in cases of urgency, in the way these tracks are used."

It seems, to judge by the summaries of the reporters, that the conclusions drawn up by Messrs. Weissenbruch and Verdeyen correspond to the list of questions. As Mr. Verdeyen has stated, Mr. Ulbricht has agreed to these conclusions subject to some small modifications in thewording, so that it is reasonable, in my opinion, to take the conclusions of Messrs. Weissenbruck and Verdeyen as basis of the discussion. I have also thought that we might request the reporters to meet at the end of the discussion in order to draft joint conclusions. Of course, the discussion will show whether this idea should be carried out : in the first place we will have to see whether there are any marked differences of opinion.

What do you think of this general programme ?

Mr. Ulbricht. (In German.) — I agree unreservedly to the proposal that the conclusions of Messrs. Weissenbruch and Verdeyen should be taken as basis for the discussion ; I have come to an agreement with them ; nevertheless I would remark that the report of Messrs. Weissenbruch and Verdeyen deals above all with power-operated central apparatus and leaves hand-operated apparatus out of consideration. The question really related to central apparatus generally, and improvements made in them, consequently also to hand-operated apparatus ; accordingly I included the latter in my report. I therefore think that if the discussion is based on the conclusions submitted by Messrs. Weissenbruch and Verdeyen, it will be necessary to devote separate attention to the improvement of hand-operated central apparatus. As regards that part of the discussion, the proposals made at the end of my report might serve as convenient basis.

It will accordingly content myself, for the moment, with recording that our programme will not be complete, as regards section A, if we adopt Messrs. Weissenbruch and Verdeyen's conclusions, because they do not include the improvements in hand-operated apparatus. Of course, the order in which the different sections are discussed is a matter of indifference.

The President. (In German.) — I think that Mr. Ulbricht's remarks should be taken into consideration, although I am informed that the wording of the question does not, strictly speaking, include central apparatus operated by hand. It is true, on the other hand, that the question has been enunciated in a general form and we can hence very well include hand apparatus within it. The best way of meeting Mr. Ulbricht's view would no doubt be first to discuss central apparatus operated by hand, and then go on to power-operated apparatus.

Mr. Verdeyen. (In French.) — Mr. Ulbricht then proposes to take as basis the conclusions which I have the honour to

submit to you. But he also asks that the question of hand-operated apparatus should be discussed.

I think I must observe that neither Mr. Carter's report, nor ours, consider these installations.

Hence I would like to see — and such is my proposal — that the question of hand-operated apparatus should be inserted among the agenda for the next session.

The President. (In German.) — I think it would be better if we discussed the whole question thoroughly. It does not seem, moreover, that there is any difference of opinion. In the first place we might discuss the question as a whole, but without going too far into details. As hand-operated apparatus represent the type most used up till now, I would not exclude them from the discussion, but would repeat the proposal I have just made as regards the order to adopt. We shall then see whether or no we have to make any additions to the conclusions. I will accordingly ask you to decide, as regards improved installations, as to the chief improvements made in central apparatus operated by hand.

In this connection, Mr. Ulbricht has already observed that the question arises whether rodding or wire is best for the transmissions. That question seems to be one of a very practical order and which has no doubt given rise to many different observations, so that it would be of interest to all administrations to know the results obtained in practice.

Mr. Ulbricht. (In German.) — As this question is only considered in my report, we could take as basis for the discussion the first fourteen conclusions in my report (1). The more important questions in connection with central apparatus operated by hand are there given. One could perhaps pass from one point to the next and say whether the summary given in that part of my report meets with your approval. It is a simple proposition which I am making.

The President. (In German.) — I will accordingly propose that a general opinion should be expressed about what Mr. Ulbricht says in that chapter of his report, which deals with hand-operated apparatus. The reporter himself has nothing to add.

Mr. Rank, Austrian State Railway. (In German.) — It is said in clause 9 of the conclusions of the report :

> The intercalation of control locks in the wire transmissions of signals is not quite without influence on the certainty of the operation; nevertheless it is frequently used in order to simplify the installations.

Thus it is recorded that such control locks exist. Now from the point of view of safety, there is no reason for congratulating oneself on this. This always involves a risk for the working of the signal, as the lock prevents the transmission wire from returning to its normal position. I think it is advisable to add to clause 9 a supplementary sentence to this effect; it might for instance be said that this device is only rational if the lock does not interfere with the return, should a wire break.

Mr. Ulbricht. (In German.)—That interpretation is perfectly exact. In any case,

(1) See page 62 of the report, and also *Bulletin of the Railway Congress*, January 1910, p. 354.

the point is dealt with at greater length in the body of the report. The wording of clause 9 is merely intended to express the facts as shortly as possible. I think that I drew sufficient attention to the question by the statement that devices of this kind, however well designed, are not without influence on the certainty of the operation. No doubt, among these devices, there are some which act very differently. Some of them are constructed so that they affect the operation very appreciably; but on the other hand, improved types of control locks have lately been invented which but little affect the certainty of the operation. Actually I am not in favour of such intercalations which always have some disadvantages, but I know that some very careful administrations use such control locks and intend to continue to use them in future; accordingly I have worded the clause so that the intentions of these administrations should not be in absolute contradiction with the practice which we shall perhaps approve here.

The President. (In German.) — What would be the wording of the addition? And does Mr. Ulbricht approve?

Mr. Ulbricht. (In German.) — In my opinion, no addition is necessary; but if it is really desired, I will not oppose it. We might say : " Particular care should be taken, however, that the intercalation of a control lock should not form any obstacle to the operation of the wire transmission ", or " that certainty of the operation of the wire transmission should not be reduced by the control locks."

Mr. Rank. (In German). — It would suffice to say that the return to normal position must not be impeded by the control locks.

The President. (In German.) — I would ask Mr. Rank, and generally speaking all delegates who wish to propose amendments to any conclusions, to reduce them to writing. The bureau cannot undertake the work of drafting.

Mr. Dufour, *reporter.* (In French.) — It is not necessary to introduce Mr. Rank's amendment. What is stated in the conclusion is the practice everywhere.

Mr. Jullien, Orleans Railway. (In French.) — I should like to make some general remarks.

Mr. Ulbricht's conclusions do not apply to all countries. They more reflect what is the practice in Germany than what is done elsewhere. Thus after speaking of the modern evolution of operating switches from a distance, it is stated :

> The operation of switches by means of rod transmissions is preferred to a smaller extent, in some cases only under special local conditions; such transmissions are less liable to fracture, but any fracture is not controlled automatically as easily as in the case of double-wire transmissions.

Now in France and in England, the operation of switches by rodding is the usual practice and only in exceptional cases is operation by wire adopted.

This conclusion can accordingly not stand.

If the statement is true for Germany it is not so for England and still less for France.

Clause 5 of the same conclusion runs :

> The most usual way of securing the blade is by a thrust obtained from a special point of

support, but switch locks in which the blade and stock rail are clamped together are now used more extensively.

That is true neither for England nor for France. I even think that such a thrust would be difficult with us; as regards clamping, this assumes the switches to be operated in a particular way.

A little further on, I see :

The locking of switches is only applied to a limited extent, apart from the control locking of switches which are far off.

On the Orleans Railway, this operation is often effected by locking from a distance.

The conclusions also include :

Double-wire transmissions are exclusively used for the operation of signals at a distance.

Now on many of the French railway systems, single-wire transmissions are used.

Finally I have a remark to make about clause 12, which runs as follows :

The use of ball bearings and roller bearings in switch and particularly in signal installations has proved advantageous; but as yet they are used only to a limited extent.

On the system of the Orleans Railway, ball bearings are used exclusively.

Mr. Ulbricht. (In German.) I leave it to you to decide whether or not to adopt as definite conclusions the proposals I submitted to you in my summary. As I have already told you, I did not draw them up from this point of view; they represent on the contrary the results of my inquiries addressed to Bulgaria, Denmark, Germany, Luxemburg, Norway, Austria, Hungary, Rumania, Russia, Sweden, Switzerland, Servia and Turkey. I of course did not mean to assert that what I said applied also to France and to England. As I have already remarked, these proposals are not conclusions strictly speaking, but must only be considered as a summary of what exists in the States which I have just enumerated and as applying to them only, but not as conclusions applying equally to all the countries represented here; that is a point which I wish to emphasize once more. In my opinion, the best practical solution would be simply to come to an agreement whether the proposals contained in those paragraphs express, as regards the countries in question, existing conditions with sufficient accuracy to be considered in that sense as conclusions. I do not know whether this would be in accordance with the usual practice of the Congress; in any case, the state of affairs seems to me the same as in the case of the report of my colleague which deals with the Dutch railways. In that case also it could not be said, that the conclusions given are of general application.

Mr. Verdeyen. (In French.) — In the interests of the discussion, it would be advisable to postpone the question of hand-operated apparatus to a future session, all the more so as all the information we have before us today is that relating to Holland and to that part of Europe to which Mr. Ulbricht's inquiries were addressed.

Mr. Maison, ministry of public works, France. (In French.) — It seems that in the first part: Central apparatus with hand operation, it is not a question of mechanical apparatus, but of apparatus operated by hand.

I find the following among Mr. Ulbricht's conclusions :

In the case of important switches taken from the facing side, whether the transmission be by rod or by double wire, it is in many cases considered necessary to have control locking in addition to the locking of the cabin apparatus.

That means to say that in many cases one must not be satisfied to lock the switches, but must also have controlling gear.

That conclusion appears to me to require an addition.

In France, facing switches over which trains may have to run at speed are always locked and generally fitted with an electric control. But this electric control only serves to give information to the signalman; it informs him whether the points are properly home, one side or the other, or whether on the contrary they are not home. That is not enough to ensure safety. It is not impossible, even in the case of rigid rod transmissions, for a switch lever to be pulled over in the signal cabin without the switch having moved in a corresponding way. There is then a want of agreement between the position of the operating lever and the position of the switch, and this want of agreement, which is not shown by the switch control, may cause an accident. Hence the present tendency in France is not to be satisfied with switch controls, but to work out devices making it possible to obtain, independently of the interlocking of the operating lever, a perfect agreement between the actual position of the facing points and that of the signals.

Hence it appears that clause 4 should be supplemented, as regards France, by the phrase : " The tendency is even to fit the apparatus with devices for ensuring a perfect agreement between the position of the switches and that of the signals, independently of the interlocking between the levers ".

Mr. Ulbricht. (In German.) — Perhaps one would wish to say that there is not everywhere control locking when the switch is in its normal position. In the countries considered in my report, nearly all switch operations are arranged so that the last part of the travel produces locking, and hence forms control locking. It is only in the case of very distant and particularly important switches that special control locking is used. That is the reason why it is only in certain cases that I have specified special control locking, with an independent wire transmission.

Mr. Jullien. (In French.) — The point just raised by Mr. Maison is interesting, but it seems to me to be difficult to embody it in a conclusion. It has in fact not been investigated and the reporters for the French-speaking countries do not even mention it in their work.

That being so, it would be preferable to drop the discussion of hand-operated apparatus and to postpone the question to another session.

The President. (In German.) — Several members accordingly desire that the question of hand-operated apparatus should be postponed to the next session. (*Hear, hear !*)

As there is no opposition, that shall be so.

Mr. Ulbricht. (In German.) — I must perform a duty which I have already

mentioned. Although this chapter is now to be left out of consideration, I must mention that the administration of the Swedish State Railway has asked me to state that its answer to question 16 of the list of questions is not given quite correctly; that it must be corrected in this sense that the operation can take place, not in the middle position of the lever but in each of the end positions, with an action on the central apparatus similar to that produced when a switch is burst open. (See appendix I.)

The President. (In French.) — We now pass to littera *A* of the conclusions in Messrs. Weissenbruch and Verdeyen's report.

I call upon Mr. Maas-Geesteranus.

Mr. Maas-Geesteranus, Dutch Railway Company. (In German.) — Gentlemen, I wish to remark that if we adopt Messrs. Weissenbruch and Verdeyen's conclusions, we at the same time accept those of Mr. Carter, and I will add that on our railways in Holland, we also have several electric and electro-pneumatic installations in use. The results obtained with the electro-pneumatic service are so favourable that we have decided to use it in the case of new installations. In fact, in our opinion, the maintenance is much simpler and cheaper, and failures are much rarer than with the electric systems. Among the disadvantages, there has been mentioned in the first place, leakage of air. I recognize this disadvantage; it is true that the consumption of energy is greater with a pneumatic installation than with an electric one. The reason is that in the former case the electric energy is in the first place converted into pneumatic energy. The leakages in the compressed-air tubes are, in my opinion, quite unimportant; but this is not so as regards leakages in the cylinders. On the other hand, failures are much rarer with pneumatic installations than with purely electric installations. The influence of the temperature has been mentioned; I may tell you that we have noticed nothing of the kind, It rather seems to me that in winter, for instance, there are many more failures with electric installations than with pneumatic installations, because in the latter case the amount of power available is greater.

I may also mention that on main lines we hardly use anything except switches with flexible switchblades, and it is above all the combination of electric motors with cuttable switchlocks and flexible switchblades which has given rise to failures. This has led us to give up cuttable locks, and in ordering new installations we now ask for non-cuttable locks, cuttable locks having caused too many failures.

I therefore think that we cannot yet say definitely, as regards Europe, whether pneumatic installations or purely electric installations are to be preferred. Moreover, the two other reports also state that this question is not yet decided. I therefore propose to say in the conclusions that as yet no definite opinion can be formed, or that a choice must be made in each individual case. On our railway system, we select the electric system in the case of small installations; but we prefer the electro-pneumatic system in the case of large installations, particularly when one single installation can be utilized for several central apparatus.

Mr. Verdeyen. (In French.) — I think that the remark made by Mr. Maas leads to the elimination of the clause in the conclusions stating : " A similar tendency has been found in Europe ", that is to say, the tendency of introducing more and more the use of electrically-operated apparatus. But, by agreement with Mr. Ulbricht, we have proposed to modify this wording as follows : " In Europe, electrically-operated installations at present preponderate among power installations ".

This is a record of fact.

The President. (In French.) — Does this wording satisfy Mr. Maas?

Mr. Maas-Geesteranus. (In French.) — Perfectly, Sir.

Mr. Petri, ministry of public works, Germany. (In German.) — Before passing to the discussion of littera *B*, I would draw attention, as regards the interesting reports which have been submitted to us, to a point which seems to me of particular interest, seeing the continual increase in the speed of trains. Mr. Ulbricht has already mentioned this point, leaving it to us to discuss it. Mr. Ulbricht's report, under question 59, gives us some information about arrangements provided for giving addditional security against the risk of over-running a signal, if the driver is careless. In his paper, the reporter, in considering this question, states that in order to prevent the over-running of signals, many very varied experiments have been made during the last tens of years so as to induce the driver to observe the optical signals, by means of some auxiliary means with a powerful action. He then mentions ths experiments made during the last ten years in Germany; in these the main feature is the use, in addition to the optical signals, of some automatically-acting device placed on the locomotive, intended to help the driver in the observation of the signal, by setting into action a steam whistle, a bell, etc., in other words, by providing an additional signal.

It is of course necessary that the driver should not enter dangerous sections, especially those with switches proceeded by signals, unless those signals stand at " line clear ". Greater safety would be obtained by means of devices which would prevent the driver from inadvertently over-running a signal standing at " danger ", that is to say, from passing it without observing it; for this can result in serious danger. During the last ten years many experiments have been made in Germany with devices giving on the locomotive an audible signal, corresponding with the position of the optical signals. But as yet no device has been found which has proved to be sufficiently reliable in its action.

We know that for long years experiments have also been made in other countries so as to obtain this new guarantee of safety, of giving an acoustic signal on the locomotive itself.

Now it would be of great interest to learn whether the experiments made in other countries have led to the discovery of a really reliable device giving entirely satisfactory results in practice, even when atmospheric conditions are unfavourable. If we could, in answer to question 59 of Mr. Ulbricht's report, obtain any information about this point, I think that we should elucidate a question of very great importance, in view of the increasing speed

of trains and the greater number of times the driver has to observe signals.

Mr. d'Abramson, Russian State Railway. (In German.) — I can inform you that on the Russian South Western Railway we adopted, four years ago, a device of this kind which is however not used in a general way ; I mean to say that it is only used in times of fog or of snow. It is an apparatus set in action by the station-master when it seems to him that fog or other unfavourable atmospheric conditions make this advisable. This apparatus has during these years given good results. We started with the principle that these automatic devices generally result in blunting the attention of the train employees and that great care must consequently be taken in their introduction. This is why we have adopted a device which only works when conditions are particularly dangerous.

Mr. Weissenbruch, *reporter*. (In French.) — We can but thank Messrs. Petri and d'Abramson for the information they have given us about the appliances repeating on the locomotive the track signals.

I will, however, venture to remark that this question does not fall within the scope of the question set before us. Accordingly we have not mentioned it in our report.

Mr. Ulbricht, utilizing the liberty left to the reporters, has thought it advisable to extend the scope of his observations and to consider the question of such repetition signals.

If the meeting thinks it advisable to consider it, I could in my turn give you some information concerning Belgium.

The President. (In German.) — This is in fact a question which we could probably not exhaust today, even if we had before us the answers of the different administrations; but, on the other hand, it is of such importance from the point of view of safety that no doubt it will continue to attract the attention of all administrations ; we may accordingly be able to recommend that it should be inserted among the agenda for the next session of the Congress. Mr. Petri states he agrees with this.

I now call upon Mr. Ulbricht.

Mr. Ulbricht. (In German.) — The reason why I have investigated this point in my report, and included it in the question I had to report about, was as follows : a signal placed on a locomotive and operated from a signal-cabin, by the intermediacy of the various means of transmission, is really to a signal operated from the signal-cabin. In fact, in the case of the van Braam and of certain other systems, the signalman, from his cabin, operates a signal on the locomotive, just as he operates a signal on the track. The zone of influence of the central apparatus thus extends in this case to the locomotive, and one can include any improvement in this system among the improvements made in signalling installations generally.

If everything regarding hand-operated apparatus is postponed to next session, we can but congratulate ourselves on this. As for me, I would remark that Mr. Petri's proposal is a particularly happy one and that many other members of this section would perhaps like to have fuller information about the subject; I do not

hesitate to say that I am included amongst them. The direct action of the signalman on the driver is a question which we shall have carefully to consider from now onwards. The five years which will elapse till the next session of the Congress are rather too long a period. Would it not be advisable to devote a quarter of an hour to this question already to day ?

Mr. Petri. (In French) — It would also be useful, in my opinion, to receive some information.

The President. (In French.) — We all agree that we cannot prevent anybody from giving information about any important point.

Mr. Descubes, French Eastern Railway. (In French.) — If we pass in this way from one question to another, the discussion will become confused and it will be difficult to arrive at any conclusion.

I therefore propose that we should first conclude the examination of Messrs. Weissenbruch and Verdeyen's conclusions before considering any other point.

Mr. Weissenbruch. (In French.) — I support the proposal made by Mr. Descubes to consider the question of repetition signals on the locomotive, at the end of the discussion.

I shall also have a communication to make.

Mr. Maison. (In French.) — The question can be considered after the discussion of Messrs. Weissenbruch and Verdeyen's report. This point is not in the programme, but every one of us may have some useful information to give. It seems to me inadvisable to postpone the consideration of this question to the next session.

The President. (In German.) — The discussion shows that there is a desire to consider this question at the end of the meeting. (*Approval.*)

We accordingly continue the general discussion of littera *A* of Messrs. Weissenbruch and Verdeyen's conclusions.

I call upon Mr. Descubes.

Mr. Descubes. (In French.) — Gentlemen, in reading Messrs. Weissenbruch and Verdeyen's report, delegates who are not aware of the strong movement there has been in France, during the last ten years, in favour of route-levers, might think that we have been satisfied with repeating the old trials made in Germany fifteen years ago and then given up. We find, in fact, on page 171 (1) the following phrase :

> In France several Companies and in particular the French Midi Railway, the French Eastern Railway and the French Northern Railway are following up the trials made and abandoned in Germany in 1895 of the appliances of Westend, Untertürkheim and Dresden, for operating all the points and signals of one route by a single lever.

I am sure that it has not for a moment entered the minds of the reporters to accuse French engineers of a plagiarism which is quite foreign to their habits.

Mr. Weissenbruch. (In French.) — Certainly not.

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(1) See also *Bulletin of the Railway Congress,* July, 1910, p. 3345.

Mr. Descubes. (In French.) — I felt certain of it, but nevertheless I think I must go into this question thoroughly.

The idea of route levers is a simple one, which must have occurred to most engineers occupied with signals since power signalling, which made it possible to have recourse no longer to manual labour, became practicable. As soon as the Bianchi & Servettaz apparatus became used by several companies, the Rodary & Ducousso dynamos by the Paris-Lyons-Mediterranean, the Westinghouse motors by the French Eastern, and the Taylor by the Ceinture, the question of routes arose in France and resulted in a number of solutions differing among themselves and which no doubt are again different from the solution tried in Germany.

Mr. Weissenbruch. (In French.) — We certainly only intended to say that the general notion was the same.

Mr. Descubes. (In French.) — The report nevertheless, in a note, contains the following statement :

The German patent No. 83559 taken out by Siemens Brothers' but now expired, we believe, expresses this principle in terms remarkably similar to those used in Mr. Bleynie's specification.

Mr. Weissenbruch. (In French.) — " The *principle* ", that is the *general notion*.

Mr. Descubes. (In French.) — I wish to remark that when I began my investigation, I was totally ignorant of what had been done in this way abroad, just as I was totally unaware of Mr. Bleynie's investigations which soon afterwards were applied at Bordeaux.

I regret that Mr. Bleynie is not a delegate at the Berne session; he certainly would have made a similar declaration and would have convinced you that he was not merely satisfied with the Siemens patent as footnote 2 on page 171 might show. If that had been the case, there is no doubt that the Berlin *Patentamt* would have refused to grant him a patent. Now I have heard this very morning that this German patent was issued 11 December 1901, as No. 150535. Moreover, in this case, the way in which the result is obtained is of considerable importance, and very different apparatus can be based on the same principles.

If, for instance, we take, on the one hand, the Bleynie & Ducousso apparatus, and, on the other hand, the M. D. M. apparatus of the French Northern Railway, we find that each of them includes a lever per route, that this lever controls parallel switches by means of an electric contact or a compressed-air distributor per switch, and that the control is in series, always by means of a contact or of a pneumatic distributor per switch. However, the arrangement of the board and the control show appreciable differences.

In any case, as regards the system used on the French Eastern, I do not think that any similarity could be found in previous attempts, either in principle or in execution; no railway company nor administration has had, as far as I know, the idea of controlling the routes by means of a board with levers corresponding, the one, to the entering line, the other, to the departing line.

The Berlin *Patentamt*, whose scruples you all know, has however thought that it could grant a patent for this system, on 16 August 1904, No. 182727; and it cer-

tainly would not have done this if an earlier German patent existed.

Secondly, I wish to state that the word " trials " and above all " recent trials " can hardly, it seems to me, be applied to installations at stations where there is a very busy traffic, such as Bordeaux, Nancy, Valenciennes, particularly when those trials go back to more than seven years ago, as at Bordeaux or to even fifteen months, as at Nancy.

Whatever opinion may be held as to the value of these route appliances, they must be considered as beyond the experimental stage, and, contrary to what is stated on page 172 of the report (1), we have all the information necessary " to enable us to draw definite conclusions as to the efficaceousness of the appliances ".

I now pass to the remarks made on pages 172 and 173 :

1° The reporters think that the French engineers have been hypnotized by the fear of a strike. That is a complete mistake, for what we have tried to obtain above all is a simplification of the operations, a reduction in the labour and an increase in the capacity of a cabin.

Mr. Bleynie, it is true, did talk in a note about strikes, but that is a secondary argument which would certainly not suffice to justify the adoption of a system.

The reporters add that the apprenticeship of the signalmen who are to work at a central apparatus with ordinary levers is neither complicated nor difficult. The same remark is made in the proposed conclusion where it is stated, page 182 (2): " the end in view is that of rendering more easy the apprenticeship of the signalmen ".

These opinions appeared to me singularly optimistic, when I found on page 176 (1) the statement that an apprenticeship of from two to four weeks is estimated to be required for a man selected from " the more intelligent of the employees, provided that they were conversant with the traffic of the station which they had to work ".

I agree with the reporters as to this last estimate.

I will add that, as a rule, during these weeks of apprenticeship there is a considerable reduction in the output of work in the new cabins, and that is a fact which you have all observed.

When on the contrary, I put in service cabin No. 4 at Nancy, the signalmen who had never been in this cabin did not take a day before getting used to it. The next day already, half an hour was gained in the time of operating. Yet the zone of action of the cabin had been materially increased; it had to look after the passenger and goods trains going towards Strasburg, Epinal, Mirecourt, all the locomotives going back to the sheds or coming from them, and a large number of sets of empty passenger carriages, either for clearing them or for making up trains.

2° Secondly, the reporters think that cabins with individual levers are more convenient when it is necessary to operate a track appliance singly for purposes of inspection or of maintenance. Now the cabins of Bordeaux, like those of Nancy, include individual commutators and the

(1) See also *Bulletin of the Railway Congress*, July, 1910, p. 3346.

(2) See also *Bulletin of the Railway Congress*, July, 1910, p. 3356.

(1) See also *Bulletin of the Railway Congress*, July, 1910, p. 3350.

cutting out of an appliance presents no difficulty.

In order to avoid any disturbances, lead-sealed apparatus are used which work perfectly satisfactorily.

Mr. Weissenbruch. (In French.) — Is the safety the same?

Mr. Descubes. (In French.) — Absolutely. If the signal is not in the proper position, it cannot be opened.

Mr. Weissenbruch. (In French.) — Once the seals are gone, the interlocking is done away with. This is the position until the electrician has arrived at the cabin to re-seal the apparatus. Consequently that is not the same thing.

Mr. Descubes. (In French.) — 3° According to this remark, the economy of time is illusory.

It would be difficult to make one believe that it is as quick to operate in succession perhaps five or six switch levers, a route handle and a signal lever, as to operate one or two levers only.

In fact at Nancy not more than five seconds are required to make a route, to lock the switches and to set the signal to " line clear ".

I may be told that a difference of five seconds is negligible; but in the first place we must double this figure in order to allow for returning to the normal position. In the second place, when three or four movements have to be made simultaneously, a total difference of ten seconds in time of operation is of importance.

On the French Eastern Railway the traffic department which had so to say had nothing to do with the construction of the cabins at Nancy and thus was quite unprejudiced, took into consideration, before asking to have its cabins developed, the consequences from the point of view of safety, and of the facility and quickness of operation of the apparatus, of the output of work and of the expense.

I will ask your permission to read some of the conclusions of the report of the engineer charged with making these inquiries :

... Cabins D show a remarkable simplicity and ease of operation. It is enough, in fact, for the signalman to know where given vehicles come from and whither they are going, to make a route merely by operating two levers without any effort. The quickness of the operation is not reduced, seeing that all the switches concerned in a given route are operated simultaneously and that the throwing-over of points is so to say instantaneous.

... These cabins also have the great advantage of increasing very appreciably the traffic capacity of the stations. The considerable reduction in the number of the levers, together with the quickness and the ease with which the routes are made, make it possible to give such cabins a zone of action which is very great. Now from the point of view of the traffic capacity of a station, it is very advantageous to concentrate the whole work in the hands of a single signalman.

... The operations are carried out under safer conditions and much more quickly than formerly.

I may add that at Nancy the saving amounts to having ten switchmen less; on the other hand, we have three electricians. Thus there are seven employees less.

The end of the report says :

The results given by this system at Nancy are all the more remarkable as the cabin to which it has been applied is certainly not very suitable for it.

It accordingly seems that it would be advisable to adopt it for large cabins where much traffic has to be dealt with.

In France one objection has been raised to these route cabins, which I am surprised not to find in the report. It has been said that clearing treadles were required, and consequently operations were lengthened by the necessity of clearing a route completely. This criticism can be equally addressed to the system with individual levers and clearing treadles. But this disadvantage can easily be overcome by using, as we do at Nancy, operating commutators which make it possible to break up the route before the treadle is cleared and which, in a second movement, lock the new route which is made.

Mr. Verdeyen. (In French.) — That is also done in Belgium.

Mr. Descubes. (In French.) — In order not to prolong this explanation, I will later on answer a few words to remarks 4° and 5°.

I will conclude this discussion by mentioning the advantages which I think route levers possess :

1° In the first place, I must mention simplicity of operation. With the Bleynie system, or with the M. D. M. system, one operates one lever. With the Nancy system, one operates two : that of the track of entry and that of the track of departure ; that is to say, the signalman has only to note down in the simplest manner the order he has received by telephone from the station or from the official in command.

This results in a reduction in the mental effort, which the reporters mention with justice in their remark 4°, page 173 [1];

2° Interlocking from cabin to cabin, the protection of trains stopping at a station, can be realized more easily than with any other system. This is what has been done with a simple commutator at Nancy, where the route can be blocked as regards arrival, while remaining free for departure;

3° Operation is quicker, and consequently the output of the station is increased, as experience has shown. I will not return to this point which I have dealt with at length;

4° From the point of view of the working expenses, we have to consider the maintenance proper and the cost of the staff. As regards the former, it is clear that the cost of maintenance of the motors and of the apparatus itself must be practically the same, whatever the system, but the cost of current may be lower in the case of route apparatus. In fact, in the latter system, it is possible to cut off entirely the operating current and the control current of a switch whenever no route affecting that switch is made; this also has the advantage that the conductors of the motors do not remain charged.

These two conditions are, it is true, satisfied by the Siemens Brothers apparatus, but not by the Siemens & Halske apparatus.

As regards the cost of the staff, it can only be less in the case of the route apparatus, at least at important cabins, where several signalmen are required if individual levers are used.

In fact, on the one hand, operations are

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[1] See also *Bulletin of the Railway Congress*, July, 1910, p. 3347.

carried out more quickly; on the other, the size of the cabin can be appreciably reduced by reducing the number of levers.

In order to make this clear, I will take as an instance a cabin which we are at present designing for a central station, where we will have to operate 102 switches and 61 signals and where the number of routes possible, including diversions, is exactly 200 in each direction. With a Saxby cabin, there would be necessary a frame of 187 working levers, including the lock levers. If we took the latest type of Siemens & Halske apparatus mentioned on page 161 (1), there would be necessary, if I understand the description properly, 65 point levers, 200 route handles, total 265. With the Nancy system, 64 levers suffice.

All these reasons make it impossible for us to accept the conclusions in the report which seem to us too severe.

Mr. Weissenbruch. (In French.) — I should like to say a few words in answer to the remarks made by Mr. Descubes. But as it is already late, I will do so at this afternoon's meeting.

Meeting held on 9 July, 1910 (afternoon).

Mr. Weissenbruch, *reporter*. (In French.) — As against what Mr. Descubes seems to think, I must assert that we did not for a single moment intend to accuse the inventors of the French apparatus of plagiarism. It is true that we have recalled the trials made in Germany in 1895, and then given up, but we have only had in view a question of principle and we have not wished to dispute the originality of the French apparatus. In fact, the idea of operating several switches by the movement of one single lever must have occurred to all those who occupied themselves with the question of switches and signals.

The phrase which is found on page 171 of our report and which Mr. Descubes has criticized is but the summary of a passage in a note, describing the installation of Antwerp, published in the *Bulletin of the Railway Congress*, August 1904, p. 667.

This passage is as follows :

The principle of Mr. Bleynie's system is that only one movement of a lever is necessary for each train. The movement of the lever includes two parts. In the first, the switches are operated. When these have assumed the required position, a controlling current releases the lever and makes it possible to move it further; this places the corresponding signals to safety and clears the line. The disavantage is that, in order to make it possible to act in case of any failure, it is necessary to have an emergency commutator in the cabin making it possible to operate all the switches and signals independently. This commutator is placed behind a glazed door, of which the station master keeps the key, and it is forbidden to use the main apparatus when the emergency apparatus is in use; but we know how difficult it is to ensure that such rules are never broken.

Experience is already available on this point. Messrs. Siemens and Halske patented in 1895 (2) a similar system which could easily be applied to their old patterns of cen-

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(1) See also *Bulletin of the Railway Congress*, July, 1910, p. 3335.

(2) German patent No. 83559.

tral apparatus at Westend, Untertürkheim and Dresden. All the switches concerned in a given route were operated at once by the route lever, and all the signals by another lever.

These paragraphs prove that we did not for a single instant wish to cast any doubt on the originality of the apparatus tried in France. We merely remarked that trials based on the same principle had been made previously in Germany.

Moreover, in the same report we have fully acknowledged the ingenuity of the French apparatus, for on page 173 (1) we say :

> We think that we may conclude that, *in spite of the ingenuity which has been devised with a view to substituting route operation for single lever working*, the advantages of the latter system are such that owing to the conditions of the problem to be solved, they will finally prevail.

The whole question comes down to this : our opinion differs from that of certain French engineers and we continue to believe that with individual levers the same practical results can be obtained as with route levers, without the complications that the latter involve.

As regards the expression " recent trials ", that refers purely to the Descubes system and to the M. D. M. apparatus, tried respectively at Nancy station and at Paris-Nord. According to Mr. Descubes' own statement, the Nancy trials now date back fifteen months. So then they were recent at the time we prepared our report.

(1) See also *Bulletin of the Railway Congress*, July, 1910, p. 3347.

Mr. Descubes has also referred to the following passage on page 176 (1) :

> An apprenticeship of from two to four weeks according to the magnitude of the installation has been found amply sufficient to familiarise them with the operation of the appliances, since this is generally much more simple than that of mechanically operated appliances.

In this connection, we can give him some fresh information. This period of two to four weeks is a very relative matter. We meant to say that before putting the new apparatus into use in Belgium, we placed the signalmen during this time in the cabin, *when it was possible to do so*. At Alost we simply placed the signalmen *in the station* for a fortnight and we made them acquainted in advance with the plan of the station, with the location of the switches and the signals, and their numbering. It was only possible to make them enter the cabin, in order to learn the work, twenty-four hours before it was used. Everything went well, for there was no appreciable delay in the movement of the trains from the time that the new installation was put in service.

Mr. Verdeyen, *reporter*. (In French.) — Mr. Descubes has said that there is a means of avoiding any disturbances by having lead-sealed appliances near the signalmen.

As for us, we think individual operation is preferable, seeing that in case of the failure of a switch, one can go on with the regular operation of the central apparatus and still have the guarantee of the mechan-

(1) See also *Bulletin of the Railway Congress*, July, 1910, p. 3350.

ical interlocking of the cabin. Attention need only then be given to one broken-down switch.

On the other hand, if one operates with arrangements normally sealed, any mistake is possible, for there is no longer any interlocking.

As regards the new M. D. M. system, I have had the opportunity of seeing the apparatus while being made at the workshops of the Aster Company; I had remarked that it would be easy to operate the switches by means of individual switches. I saw with satisfaction, at the Brussels exhibition, that the Aster Company had applied to an apparatus of this kind a device making individual operation normally possible.

Mr. Tettelin, French Northern Railway. (In French.) — That had been decided in advance.

Mr. Verdeyen. (In French.) — I was not so informed at the time I paid my visit.

According to Mr. Descubes, not more than five seconds are required, at Nancy, for making a route, locking the switches and setting the signal. We have stated that eight seconds are required with the Belgian electric apparatus with individual operation.

In connection with this point, we may remark that in order to make a route, it is evidently necessary to have : 1° the time required for operating the switchçs and for the action of the control current; 2° the time required for operating the signals so that they may show " line clear ".

Now a switch is operated in the same time, whether we use a route lever or an individual lever; the motor must have time to complete its travel. The time required for this is two to three seconds, in the case of all the electric systems known. Then we must also allow two to three seconds for setting the signal to " line clear ". In Belgium, we need two seconds more, because all the routes have two signals, and the one at the end of the route must be set before the one at the beginning of the route. If the same signalling principles were applied to the French apparatus, it would accordingly be necessary to add two seconds to the figure given by Mr. Descubes. *Consequently the difference of time is only one second.* It corresponds to the actual time necessary for operating the switch levers.

As to the statement made by Mr. Descubes that 187 Saxby levers, which could be replaced by 64 Descubes levers, would require 265 levers with the apparatus in use in Belgium, we think that we may assert that we would succeed in reducing this figure of 265 if we utilized all the resources of the Belgian system. We have always succeeded in reducing the number of the electric levers as compared with that of the Saxby levers necessary for one and the same installation. At Alost, 144 electric levers do the work of 381 Saxby levers.

Mr. Weissenbruch. (In French.) — The opinion in favour of individual operation, which we have expressed in our report, is our own personal opinion ; it is not an opinion derived from the replies to our list of questions and we have not pronounced categorically in favour of the one or of the other system. We have limited ourselves to giving our opinion as engineers, members of the Congress, just as we

might have done during the course of the discussion. Hence, the reproach which has been made, but not at this meeting, that I had the report distributed too late is unfounded.

Mr. Verdeyen and I, having of late been overworked in our capacity as engineers of the Belgian State Railway, did not have the time to finish our report sooner.

Moreover, you all know that several other reports also only appeared at the last moment.

Mr. Heurteau, Orleans Railway. (In French.) — Mr. Weissenbruch has just referred to the reproach addressed to him, outside the meeting, of not having had his report distributed sooner.

It is I who addressed this reproach to him and I wish to repeat it publicly.

I regret that this report reached us so late. This regret is all the more well-founded as the General Secretary has urged all the reporters to do their work as soon as possible.

On the other hand, I must protest against certain passages in the report, in which the system applied by the French engineers is criticized in a way which seems to me to be partial and unfair.

If the Midi Railway Company had been aware of this in good time, it would have delegated Mr. Bleynie to answer Messrs Weissenbruch and Verdeyen's statements.

Mr. Weissenbruch. (In French.) — I much regret that it was impossible for us to finish our report sooner, and I once more apologize for this. But I must protest against Mr. Heurteau's words, and I see nothing unfair except his words. Many other reports came in very late. Is the General Secretary to be reproached for having, in deference to his colleagues, had their reports printed before his own?

Much greater delays have occurred at other sessions; thus I may mention that at Paris, in 1900, Messrs. Auvert and Mazen's report was handed in *after the session had begun*, and that the French companies strongly urged that it should be printed as quickly as possible, although the Permanent Commission had decided not to take into consideration reports which were received so late.

Mr. Heurteau has just said that we have been partial, in an unfair manner, in the case of the system applied by the French engineers. I regret that he has made use of such an expression. It is not our habit to show partiality towards anybody in an unfair manner; to say so is to misunderstand our character.

However, that may be, I am glad to be able to take the opportunity of this attack to affirm categorically that such has never been our intention.

If Mr. Heurteau alludes to the passage Mr. Descubes referred to, I will repeat what I have already said. That passage is only the summary of a note which one of us published in 1904 in the *Bulletin of the Railway Congress*. Mr. Bleynie, whose name was mentioned therein, has had plenty of time to answer it since.

Mr. Heurteau. (In French.) — I do not know what your intentions were, but if Mr. Bleynie could have seen your report in good time, he would have come here in order to answer the note given on page 171 [1] which was unfair to him :

The German patent No. 83,559 taken out

[1] See also *Bulletin of the Railway Congress*, July, 1910, p. 3315.

by Siemens Brothers' but now expired, we believe, expresses this principle in terms remarkably similar to those used in Mr. Bleynie's specification.

Mr. Weissenbruch. (In French.) — We have said : " this principle... " At page 160 of the report (1) full details are given of the chief points in Mr. Bleynie's system.

Mr. Heurteau. (In French.) — It is a question of what is discussed at the Congress. If your report had been issued in good time, Mr. Bleynie would have come here to answer you.

The President. (In French.) — It follows from the remarks which have been interchanged, that Messrs. Weissenbruch and Verdeyen had not the least intention in the world of criticizing the French engineers.

This incident is accordingly closed and I call upon Mr. Tettelin.

Mr. Tettelin. (In French.) — Gentlemen, I wish to draw your attention to that part of Messrs. Weissenbruch and Verdeyen's report in which they examine the question of the eventual generalization of the system of operation by route levers, They think that individual levers will in the long run be preferred to route levers and they draw these conclusions from five propositions which may be summed up as follows :

1° The apprenticeship of the signalmen is neither more complicated nor more difficult with the individual lever than with the route lever, if one has men who know the regular train service in the zone they have to look after;

2° The making of a route when one has a system of route levers results but in an imaginary saving of time, as compared with a system with individual levers operated at the same time;

3° and 4° One cannot hope to realize a saving, either in operating staff or in maintenance staff, by using the route lever instead of the individual lever.

Mr. Descubes has discussed these first four propositions this morning and I entirely share his opinions in this respect. I therefore will not stop to dispute their value. I will simply say that they form no argument against the route lever; these propositions in fact tend to show not that the individual lever is superior to the route lever, but simply that it is not inferior to it.

There remains the fifth proposition which is of a different nature. It is this : in case of damage, or in case of breakdowns it is often necessary to operate a given track appliance separately, and this can be done much more easily in the case of the individual-lever system than in that of the route-lever system. This argument is put out of court if the central cabin is arranged in such a way, that while operating with route levers, it is also possible, in case of necessity, to operate any switch or signal separately, *with all safety*. That is so, moreover, in the case of three of the route-lever systems described in the report; namely the Bleynie, the Descubes and the M. D. M. systems.

It is accordingly with some surprise that I see the reporters say after those five propositions :

We think that we may conclude that, in spite of the ingenuity which has been devised with a view to substituting route operation

(1) See also *Bulletin of the Railway Congress*, July, 1910, p. 3334.

*

for single lever working, the advantages of the latter system are such that owing to the conditions of the problem to be solved, they will finally prevail.

What troubles me about this conclusion, is that not only is it difficult to deduce it from the premises, but that above all it seems to me to misunderstand the origin, the importance and the future of the route lever.

What led, gentlemen, to the idea of the route lever? The desire of simplifying, and consequently, of facilitating the work of the signalmen. What does in fact the operator want? It is the power of making a route by means of as few operations as possible, and if the engineer did not at once satisfy this desire, it was because he was stopped by material difficulties; the engineer in the first place supplied the operator with separate levers, placed near each track appliance; then he grouped the levers together in a central cabin, and he succeeded in adding interlocking, to the great benefit of the operator. Then he made a single lever operate the two appliances of a cross-over; this idea, which reduces the work of the signalmen, contained the germ of the route lever. That the latter type was not evolved sooner is not at all due to the fact that the operator did not desire it; it was simply due to the fact that the engineer did not know how to do it.

Would it be reasonable, in fact, to compel the signalman to operate three or four levers, for instance, the day when it is possible to obtain a good result by only operating one lever? When a signalman has to deal with 500 trains or locomotives per day, is it not a great advantage to him to do this by 1,000 lever pulls instead of 3,000 or 4,000? And what operator would refuse to have his work lightened to this extent?

Hence, it is evident that the individual-lever system is but a step on the road towards the desirable route-lever system, and that step will necessarily be taken the day the engineer succeeds in obtaining the latter solution in a satisfactory manner.

I accordingly turn to the engineers, and ask them : do you think that the route lever will not in the long run be preferred to the individual lever, that is to say, that the problem of proper design, which is all that remains, cannot be solved? Can it be maintained, seeing past progress, that this improvement cannot be made? All the less can this be done, as the problem has already been tackled in various ways, and I think I may say, to judge by the results of the M. D. M. system, which the French Northern has investigated and installed, — and with which I am best acquainted — that this improvement has now been realized.

This apparatus M. D. M. (" *minimum de manœuvres* "), with its route lever, moreover, makes it possible, as the reporters specify with reason, to operate a single appliance, in case of necessity, with all safety. For each route, there is only one lever which simultaneously (not successively) operates all the switches and then sets the signal after the position of the switches has been automatically controlled. Finally, this control continues to exist as long as the signal stands at " line clear ".

The most remarkable feature is that the apparatus, known as the route-combiner, through which the levers act on the switches and levers, is designed in such a

way that it *automatically*, by its construction, realizes the necessary and sufficient interlocking of the levers, so that it is no longer necessary to make that careful and detailed investigation of the interlocking, required in the case of all the other systems.

You understand me : there is no longer any locking table and this leads to so much mechanical simplification that merely from the point of view of the engineer this is an enormous progress. This, moreover, has a very interesting result when it becomes necessary to rearrange the tracks or signals in the zone served by the cabin. In the case of the other systems, it is at the same time necessary to rearrange the interlocking, and that is a long, delicate and very disagreeable piece of work, for while it is being carried out, the ordinary guarantees of safety are non-existent, either altogether or partly. Both the operator and the engineer equally desire the disappearance of this critical period.

Well, the property the new apparatus has of realizing by construction all the interlocking necessary gives this result, that if one adds or if one takes away a lever — and this is done in a few seconds — the interlocking remains.

The alterations to be made in the cabin, in order to pass from the old conditions to the new, are accordingly made without at all affecting the actual safety.

That is a result which very much exceeds the modest advantages which were expected from the route lever, and the engineer finds this an advantage as well as the operator, for he obtains a much simpler and less cumbersome apparatus than those which existed before. In this branch, as in many others, the earlier solutions were complicated and it is by simplifying them that one succeeds in improving them.

There lies the future.

The M. D. M. apparatus which I have alluded to was not yet evolved in this new form when Messrs. Weissenbruch and Verdeyen drew up their report; that described by them is the primitive type and the new one differs radically.

I place on the table a short description of this apparatus (see appendix II) and I am quite ready to give those of my colleagues who are interested in the subject, any further information which they may require. (*Applause from some benches.*)

Mr. Weissenbruch. (In French.) — The normal state of affairs does not always exist at a station. Moments arrive when the switches are out of order, and as Mr. Verdeyen has stated, the route lever may involve disadvantages in such a case, while the individual lever makes it possible to continue the regular operation of the central apparatus, while maintaining the guarantee of the mechanical interlocking of the cabin.

The ideal would be an apparatus combining the advantages of the route lever with those of tha individual lever.

Mr. Verdeyen. (In French.) — I note that Mr. Tettelin agrees with us on most of the points. He has recognized, in fact, that the two systems are of equal value.

Moreover, he considers that it is an appreciable advantage of the new type of the M. D. M. system that it is possible to operate the switches individually, while retaining the safety due to mechanical interlocking. He accordingly recognizes that

the other apparatus in use in France do not realize this condition which we think absolutely indispensable in order to ensure, even in case of break-downs, the safety of the train service.

Mr. Tettelin. (In French.) — I am far from agreeing with you and considering the two systems as of equal value.

I have on the contrary shown that your arguments did not justify you in concluding that the individual lever will in the long run be preferred to the route lever, and I have expressed the opinion that the future belongs to the latter.

Mr. Verdeyen. (In French.) — We have said that the advantages of the individual lever are, in our opinion, superior to those of the route lever, taking into consideration the problem which has to be solved and the elementary conditions of safety which have to be ensured at all times and particularly in the case of break-downs.

Mr. Descubes. (In French.) — The result of this discussion is that the opinion of the reporters about those two points is unshaken.

As regards break-downs, the Nancy apparatus makes it possible do deal with them without endangering the safety. In fact by operating this apparatus, the signalman is perfectly able to make the routes in case of a break-down. I will demonstrate this whenever desired, but that is a question which it is better to discuss privately.

Mr. Weissenbruch. (In French.) — The signalman can make routes without interlocking, that is to say, without any guarantee of safety. Therein lies a question of principle. Any demonstration would be useless.

Mr. Descubes. (In French.) — As for the speed of operation, Mr. Verdeyen has given us an ingenious calculation to show it is as easy to operate with two levers as with one.

He has not convinced me and I also have no expectation of making him change his opinion. Moreover, if one considers the matter well, in the light of the explanation given about the apparatus used in Belgium, one perceives that the latter are nothing but route apparatus to which individual levers have been added, with the obligation of operating the latter before the former.

In Belgium, the route lever is not operated until after the switches have been operated. As for us, we limit ourselves simply to the operation of the route lever.

Under these conditions, I do not understand the somewhat summary way in which the reporters have dealt with the route-lever system which they have seen at work in Paris and which is much appreciated on the systems of the French Eastern, the Orleans, the French Northern and the Midi. Four French railway companies with 25,000 kilometres (15,500 miles) of track accordingly prefer it.

Mr. Verdeyen. (In French.) — What should be considered is the number of stations equipped with the improved apparatus and not the mileages of the railway systems.

From what you have just said, you acknowledge yourself that the French route levers are nothing but an extreme extension of the Belgian route levers.

Mr. Descubes. (In French.) — It is by no means my intention to force our system on the Belgian railways; but it should not be stated in the conclusions that the individual lever is superior to the route lever and that the latter is still a subject of trial.

Mr. Weissenbruch. (In French.) — We do not say this, but we maintain that the advantages of the French route levers do not make up for the complication they entail.

Mr. Tettelin. (In French.) — Indeed you do, on page 182 (1).

Mr. Descubes. (In French.) — I will again read out the sentence in the conclusions of the report:

In France, trials are in progress with a view to operating all the points of a route by means of a single lever. The end in view is that of rendering more easy the apprenticeship af the signalmen.. In Germany and in Belgium attempts to operate points simultaneously, other than those usually worked in combination for a cross-over, have been given up. In those countries, it is thought that the apprenticeship of the signalmen can always be effected quickly if they are familiar with the traffic at the station and that apprenticeship is quite useless unless they are familiar with the traffic.

As I stated this morning, it is no longer a question of " trials " at Bordeaux, Nancy and Valenciennes stations; it is a question of *applications*.

According to the report, we are giving ourselves a lot of trouble in order to arrive at nothing.

Mr. Weissenbruch. (In French.) — We spoke of trials at Nancy where according to Mr. Descubes the appliances have been in use for fifteen months. In order to satisfy everybody, it would suffice to say : " In France, applications have been made so as to operate by means of a single lever all the switches of a given route ".

If we have been mistaken as to the object you have aimed at, we shall be pleased to mention it in the conclusions.

Mr. Tettelin. (In French.) — Can it be said in the conclusions that Belgium has given up the route lever, seeing that it has never tried it?

Mr. Weissenbruch. (In French.) — It was in Germany that, after trials, the route-lever system was given up, and the Belgian railways have come to the same conclusion as the German railways. We however attach no particular importance to this wording. Above all we desired to draw attention to this question and to have it discussed here, and we seem to have succeeded only too well.

Mr. Verdeyen. (In French.) — It is a question of principle, and in Germany the principle of the route lever has been given up.

Mr. Tettelin. (In French.) — Other apparatus are in question there.

Mr. Verdeyen. (In French.) — It is a question of the same principle. We have not discussed the apparatus.

It seems to me that the question of break-downs, such as we mean it, has not been understood. In the Belgian system, when there is any failure of a switch concerned in the route, the con-

(1) See also *Bulletin of the Railway Congress*, July, 1910, p. 3356.

trolling indication is not received in the cabin. However, nothing prevents the operation of the auxiliary route lever which mechanically locks all the switches of the route and keeps them immovable during the whole passage of the train, even when a switch is out of order. Moreover, as the cabin does not receive the controlling indication, it is impossible to set the signal to " line clear " and the operation must be ordered specially.

Mr. Descubes. (In French.) — The same is the case with us.

Mr. Verdeyen. (In French.) — Perhaps with the new M. D. M. system in which all the mechanical interlocking is maintained in operating the supplementary levers of individual switches in case of a break-down. But this new system, the only one based on this principle, did not exist when we drew up our report.

Mr. Weissenbruch. (In French.) — This is very important from our point of view and I add that with the help of the route lever which we have, we can operate individually the switch which is out of order while maintaining the safety of the other switches.

Mr. Descubes. (In French.) — The same is the case with us. If the wire is broken, one operates by hand.

Mr. Weissenbruch. (In French.) — That is not the case either at Paris or at Bordeaux.

Mr. Descubes. (In French.) — A route can only be given and a signal set if the switch is in the proper position.

Mr. Jullien. (In French.) — I wish to make a remark about two statements in the conclusions. The first is :

The methods of power supply most usually employed, are, on the one hand, electric current and, on the other, compressed air with electric indicating gear.

I see that no mention is made of hydro-dynamic working; there are ten such cabins which have been working without trouble for more than twenty years on the Orleans Railway.

Hence I propose that these cabins should equally be mentioned in the conclusions.

These hydro-dynamic cabins may not be perfection; but I may state that in our experience of twenty years they have given excellent results.

Here, moreover, is a fact which I can cite in their favour.

In the month of January, during the Seine floods, the apparatus of the signal-cabins at the Paris station remained for a week under 1 metre (3 ft. 3 in.) of water. Now the very day the flood subsided, all that was necessary was to clean the apparatus, and two hours later the cabins worked as well as before.

Our Italian colleagues can no doubt confirm my statements, for this apparatus is frequently used in their country.

I do not dispute that hydro-dynamic cabins are open to certain criticisms, but it is nevertheless true that till now they have not given any serious trouble.

Mr. Weissenbruch. (In French.) — We agree that the conclusions should be modified in the way recommended by Mr. Jullien.

Mr. Verdeyen. (In French.) — One might add : " the systems of water under pressure... "

Mr. Jullien. (In French.) — The second statement runs as follows :

In the United States of America, where the latter system (compressed air with electric indicating gear) first came into most general use, electricity has taken the lead in latter years, and it is probable that it will continue to keep the lead over its competitors for the following reasons :

1° This system is more easy of adaptation and use;

2° The losses due to storage and in the distribution are very small;

3° The distribution and utilization of electric power are independent of variations of temperature or of severe extreme temperatures.

A similar tendency has been found in Europe.

That should also be modified, for in opposition to the opinion of the reporters, I do not clearly see this marked preference in favour of electric apparatus expressed in Mr. Carter's report.

Mr. Verdeyen. (In French.) — This is the new wording which we propose : " Electrically-operated installations are at present preponderating among power-operated installations."

Mr. Descubes. (In French.) — Let us say " the most usual " instead of " preponderating."

Mr. Dufour. (In French.) — I have visited cabins on many railway systems, especially on the lines of the New York Central, where I have seen numerous applications of the Westinghouse system.

On the Dutch railways, both systems are being tried and I would be very puzzled to state which of the two is better.

Our colleague Mr. Matheson has published a note, in the *Proceedings of the Institution of Civil Engineers of London*, about Glasgow station, which I have also visited. It follows from this note that when the question was discussed, the engineers were very puzzled to give a decision.

Hence the question is far from settled.

Mr. Weissenbruch. (In French.) — As for Mr. Carter's opinion, we may consider it a weighty one, as our colleague also expresses his opinion about the electro-pneumatic system, of which he is an old partisan.

The conclusion of his report is formal. Here it is :

Summarizing the situation as regards interlocking in America :

Application of power interlocking is rapidly increasing;

Electro-pneumatic and purely electric systems are superseding all other forms of power interlocking.

Mr. Jullien. (In French.) — When Mr. Carter drew up this conclusion, it seems that his opinion was not very definitely settled, for he says :

Electro-pneumatic and purely electric systems are superseding all other forms of power interlocking.

Those words show that he makes a very justifiable reservation.

These cabins have only been in use a rather limited time and the results do not yet make it possible to give the preference to either system.

Mr. Weissenbruch. (In French.) — It must not be forgotten, in understanding Mr. Carter's report, that the electro-pneumatic system was already very widely applied in the United States at the time when the first electric systems appeared in that country.

Mr. Dmitrenko, Russian State Railway. (In Russian.) — I wish to remark that Mr. Ulbricht has not mentioned in his report — probably owing to delay in the answers of the Russian railways — that in Russia, apparatus with water under pressure and apparatus with carbonic acid are also used.

Mr. d'Abramson. (In German.) — I think it will also be of interest to add that in Russia, where the variations in temperature attain 75° C. (135° Fahr.) and where on certain lines, such as the Russian South Western, in the Caucasus and even on the Nicolas line (near Moscow), the thermometer falls to —35° C. (—31° Fahr.), the Bianchi and Servettaz system has been applied, very successfully, during more than fifteen years. I am accordingly of opinion that although perhaps the future may belong to the electric and the electro-pneumatic systems, it can nevertheless be said that the hydraulic system has much in its favour in the case of small installations.

On the other hand, as regards carbonic-acid apparatus, it must be recognized that as yet no good results have been obtained with this system in Bussia.

Mr. Segré, Italian State Railway. (In French.) — I completely agree with Mr. Jullien's statement, and declare that on the Italian railways the hydro-dynamic system has been in use for a long time, ever since the beginning. It has given such satisfactory results that its application is going to be extended in all great stations, as in that of Milan.

Mr. Dufour. (In French.) — I thank the French delegates for having supplied us with information about the route-lever system which is hardly known in the other European countries, especially Holland.

The conclusions submitted to us talk of the different methods of operating switches and signals, except as regards the double-wire system.

For instance, I read the following :

The use of the fluid operated central apparatus, principally for large stations, has made rapid progress during the last ten years. Such apparatus has the advantage of allowing of greater concentration, and, consequently, greater safety and greater rapidity of operation, while at the same time it renders more easy the work of the employees.

I do not think that there is greater safety than with double-wire apparatus. We use the latter in Holland and obtain excellent results.

The conclusions also state :

It is also possible to obtain greater safety in working the traffic by arranging for the clearing of the routes by the train itself, by indicating the true position of the points, by obtaining the return to normal or stop position of signals after the train has passed (or in case of any disturbance in the route run over), etc.

In nearly all the apparatus used in Holland, the same results are obtained by means of a battery current.

That sentence should accordingly be struck out of the conclusions.

Further on I read :

In large stations to which an electrician is permanently attached, the concentration has led to a reduction in the number of signalmen. By this means, it has been possible to recoup the expenditure in capital while at the same time greater safety has been obtained than that which was formerly given by the old mechanical installations.

And on page 175 of the report (1), the reporters compare the cost of installation of the Siemens & Halske system and that of the Saxby system. With the latter, the cost would only be 400,000 francs (£16,000), while with the former it was 440,000 francs (£19,600). I feel convinced that one could have adopted the double-wire system, with two cabins, and in that case the cost would only have been 200,000 francs (£8,000).

We also have double-wire cabins where the operations can easily be carried out by two signalmen and I think that two men would equally be required with electric operation.

Mr. Verdeyen. (In French.) — The figure of 400,000 francs (£16,000) quoted also includes all the additional safety appliances, consisting of electric apparatus, added to the Saxby system so as to realize the full advantages given by the electric operation of switches and signals. Hence, the figure of 200,000 francs (£8,000) given by Mr. Dufour for the double-wire installations would have to be materially increased, in order to allow for the carrying out of this programme and to make a comparison.

I however propose to modify the wording and say : " In very large stations... ", and to leave out the statement referring to increased capital expenditure.

Mr. Dufour. (In French.) — Exactly.

The President. (In French.) — As nobody else wishes to speak in the general discussion, we will proceed to examine the conclusions, the first paragraph of which runs as follows :

" Littera *A*. — The use of the fluid-operated central apparatus, principally for large stations, has made rapid progress during the last ten years. Such apparatus has the advantage of allowing of greater concentration, and, consequently, greater safety and greater rapidity of operation, while at the same time it renders more easy the work of the employees It is also possible to obtain greater safety in working the traffic by arranging for the clearing of the routes by the train itself, by indicating the true position of the points, by obtaining the return to normal or stop position of signals after the train has passed (or in case of any disturbance in the route run over), etc."

Mr. Jullien. (In French.) — Although we are not discussing the question of mechanical installations, it is advisable to say a word about them at the beginning of the conclusions.

I accordingly propose the following wording :

" Although hand-operated apparatus are by far the most common and give satisfaction, the use of fluid-operated central apparatus has made rapid progress during the last ten years or so, particularly at very large stations, etc."

Mr. Weissenbruch. (In French.) — It is also important to state that where current is available, the safety can be increased with hardly any extra expense, by having a few extra wires in the cables.

Mr. Gérardin, French Eastern Railway. (In French.) — That is a very minor point.

(1) See also *Bulletin of the Railway Congress*, July, 1910, p. 3349.

Mr. Weissenbruch. (In French.) — Nevertheless it is true that when operation is effected by means of electricity, one can have much greater safety without hardly any new expenditure.

At Brussels-Midi station, the Belgian State Railway has had to incur considerable expenditure in order to obtain complete safety by adding supplementary devices to the existing mechanical apparatus. If we had concentrated the whole into a single cabin by simply adopting electric operation, we would have effected an important saving in working expenses.

Mr. Gérardin. (In French.) — If one succeeded in finding the ideal cabin, one would not hesitate at the expense. It is not because there is already current that some supplementary contacts will be added.

The question of safety is more important than that of working.

Mr. Weissenbruch. (In French.) — At Brussels-Midi station we spent 200,000 francs (£8,000). Now with 300,000 francs (£12,000) we could have had a complete electric installation which would have enabled us, I repeat, to effect a considerable saving in working expenses.

The question of economy is actually of great importance, once the safety has practically been ensured. It is always this question which makes railways hesitate to adopt improved installations.

On the whole, we agree; but you are under the impression that increased safety can be obtained by means of a few accessory appliances, that is tosay, subject to a small expenditure. Now this is not the case when one wants to add to a mechanical installation all the advantages of safety which the electric systems afford.

Mr. Jullien. (In French.) — It would be preferable not to urge the question of the expenditure required in order to settle and obtain a control.

On the Orleans Railway, the investigations of this problem has shown us that the solution would not involve a large expenditure.

It is true that in an electric cabin it is technically very easy to obtain absolute control, but that is not a reason for condemning mechanical cabins from this point of view.

Mr. Gérardin. (In French.) — We must not condemn any system, but everybody must be left his liberty.

Mr. Jullien. (In French.) — One might say : " It makes it at the same time possible to obtain complete safety, etc."

The President. (In French.) — As nobody else wishes to speak, I propose that we should provisionally adopt the first paragraph as amended by Mr. Jullien. (*Approval.*)

These are the next clauses :

" The methods of power supply most usually employed, are, on the one hand, electric current, and, on the other compressed air with electric indicating gear.

" In the United States of America, where the latter system first came into most general use, electricity has taken the lead in latter years, and it is probable that it will continue to keep the lead over its competitors for the following reasons :

" 1° This system is more easy of adaptation and use;

" 2° The losses due to storage and in the distribution are very small;

" 3° The distribution and utilization of electric power are independent of variations of temperature or of severe extreme temperatures.

" In Europe, electrically-operated installations are the most used form among power-operated installations."

Mr. Descubes. (In French.) — I have proposed that in the last sentence the word " preponderating " should be replaced by " most usual ".

Mr. Gérardin. (In French.) — The word " preponderating " is too categorical.

— The wording, so amended, is provisionally adopted.

The President. (In French.) — This is the continuation of the conclusions :

" In the case of isolated appliances, carbonic acid gas has been used with success.

" In large stations to which an electrician is permanently attached, the concentration has led to a reduction in the number of signalmen. By this means, it has been possible to recoup the expenditure in capital while at the same time greater safety has been obtained than that which was formerly given by the old mechanical installations.

" In France, trials are in progress with a view to operating all the points of a route by means of a single lever. The end in view is that of rendering more easy the apprenticeship of the signalmen.

" In Germany and in Belgium, attempts to operate points simultaneously, other than those usually worked in combination for a cross-over, have been given up. In those countries it is thought that the apprenticeship of the signalmen can always be effected quickly if they are familiar with the traffic at the station and that apprenticeship in quite useless unless they are familiar with the traffic.

" Up to the present, the central electric installations have been operated by continuous current. Single phase alternating current and three-phase current have also been tried. Up to the present the following difficulties have been met with : difficulties of insulation, increased cost of the motor and of the electro-magnets, noise made by the motors when stopped, risk to the staff, and the impossibility of dispensing with accumulator storage."

Mr. Gérardin. (In French.) — I propose to replace this text by the following which corresponds to the truth :

" Since several years, applications have been made, in France, of route-lever apparatus. Attempts have been made, by means of these apparatus, to simplify the regular work of the signalmen, to increase in this way the output of the cabins, and to make it possible moreover, in exceptional cases (great rush of passengers, more or less serious breakdowns in the working) where the ordinary practice has to be modified, to carry out the service under easy and quick conditions.

" In Germany and in Belgium, etc..."

Mr. Weissenbruch. (In French.) — I propose to strike out in the paragraph the following sentence :

" In France, trials are in progress with a view to operating all the points of a route by means of a single lever."

Mr. Gérardin. (In French.) — When one

reads the report, one recognizes that the reporters are not partisans of the route lever. They have given their opinion and if we strike out some of the passages in the conclusions, we should have the appearance of admitting the considerations set forth in the report.

Mr. Descubes. (In French.) — The report does not concern the countries using the German language, and yet both Germany and Belgium are concerned in the conclusions.

Mr. Weissenbruch. (In French.) — As we state in the preamble of the conclusions, we have endeavoured to give a wording which would be acceptable to all countries. We came to an agreement with Mr. Ulbricht.

Mr. Descubes. (In French.) — If that is so, I do not insist.

— The last paragraphs are provisionally adopted.

The President. (In French.) — The definite text of the conclusions will be submitted to you on Monday morning.

We now pass to littera *B*, which runs as follows :

" Littera *B*. — 1° Mechanical and electrical appliances are in use for locking the points during the period while they are being run over by the trains. These arrangements, which should have a length at least equal to that of the greatest distance between the wheel centres of vehicles in use on the railway system, are not generally applied except in the case of points taken facing.

" There is a tendency on the continent to gradually substitute electric treadles for mechanical treadles.

" 2° Electric treadles are generally worked by means of a normally flowing current interrupted by means of a foot-operated economiser switch ; by this means the difficulty of insulation of the points can be easily overcome.

" 3° The arrangements at the end of a route, acting only after the last wheels have passed, enable all the points on a route to be interlocked up to the moment at which the train has entirely cleared the route. The use of these arrangements may be substituted for a series of locking bars at the points with economy."

Mr. Verdeyen. (In French.) — We propose to replace the word " gradually " by " in numerous cases ".

Mr. Tettelin. (In French.) — The tendency to substitute electric treadles for mechanical treadles has not been very marked in France.

Mr. Weissenbruch. (In French.) — There is a very definite tendency, according to the answers which we have received.

Mr. Tettelin. (In French.) — Mr. Jullien, who is prevented from attending this meeting, has asked me to state that the Orleans Railway has for some time been trying a new type of mechanical treadle, 12 metres (39 ft. 4 in.) long, on the Lebeau system.

Mr. Jullien thinks that this treadle, which is not overloaded, is much superior to the electric treadle.

Mr. Weissenbruch. (In French.) — Frequently often have we thought that the

problem was solved, but investigation has proved that this was not the case.

Mr. Tettelin. (In French.) — At the present moment, on the French Northern and on the Orleans, there is a clear tendency in favour of this new mechanical treadle.

Mr. Weissenbruch. (In French.) — During my travels in America, I was everywhere told that one kept to the mechanical treadle. When I remarked that this appliance did not give any safety, I was told that I was mistaken.

Now I find from Mr. Carter's report that all this is changed now and that the electric treadle is quickly spreading over the United States.

Mr. Descubes. (In French.) — On the French Eastern Railway, we have extended the use of electric treadles, although they present a certain danger to which I wish to draw the attention of the section.

The Belgian State Railway, we read in the report, is systematically generalizing the use of electric treadles 15 metres (49 ft. 3 in.) in length, to points taken from the facing side.

That length seems to me short, and for this reason.

When there is a mechanical treadle, this acts at the same time as the bolt unlocking the switch. One can hence no longer affect the position of the switch as soon as a wheel touches the treadle. With the electric treadle, the effect is not the same. For in order to operate the facing switch, one begins by sending an electric current to the treadle; if there is no wheel on that treadle, current returns to the bolt, excites the relay and one can then operate the handle of the lever. Starting from that moment, the lever is free and remains free even if a locomotive reaches the treadle immediately after the unlocking. The signalman can accordingly operate the switch under the train, between the moment that he acts on the handle and the moment he throws over his lever, plus the time the train requires for running the distance from the beginning of the treadle to the nose of the switch. Now a quick train running at 120 kilometres (74·5 miles) per hour does not require half a second to run a distance of 15 metres (49·21 feet). An electric treadle limited to this length can accordingly give false safety, unless the signal interlocked with the switch is quite near to the treadle

The French Eastern Railway has accordingly decided to have electric treadles 24 or 36 metres (78 ft. 8 in. or 118 feet) long, so as to avoid accidents. We even increase this length whenever this is possible.

On the French Eastern Railway the mechanical treadle is raised the moment the switch begins to act and it remains raised during the duration of the movement.

Our stop signal is generally placed 100 mètres (109 yards), sometimes 120 metres (131 yards), in front of the nose of the switch. If that distance was only 20 metres (22 yards) and if all the part in front of the switch was insulated, the occurrence I have described could not happen, because the signalman must have set the signal to danger before touching the switch lever.

I do not assert that this danger is great, but I nevertheless think it advisable to draw the attention of the Congress to a

point which is but little known, and as there is no disadvantage in increasing the length of the insulated rails one should not hesitate to do this.

Mr. Verdeyen. (In French.) — This is the wording proposed by Mr. Motte :

" Electric treadles have been substituted, in many cases, for mechanical treadles."

Mr. Weissenbruch. (In French.) — One might say :

" Electric treadles, the length of which one can easily be increased, have been substituted in many cases for mechanical treadles. "

Mr. Tettelin. (In French.) — I propose to add the words " and usefully " after the word " easily ".

Mr. Descubes. (In French.) — One must not go too much into detail.

Mr. Gérardin. (In French.) — Why does one return to the release of routes? We have already spoken about it in littera *A*. It is the same idea again.

Mr. Weissenbruch. (In French.) — We must take the conclusions of littera *B*.

— Littera *B* is provisionally adopted.

The President. (In French.) — This is littera *C* :

" The use of a graphical method enabling the investigation of the best utilization of tracks serving passenger platforms may be of very great service, particularly in the case of modification of the track arrangement.

" The method used by the Belgian State Railway in particular affords a general and complete solution of this problem. "

Mr. Gérardin. (In French.) — The last sentence seems to me to be useless and I propose that it should be struck out.

Mr. Weissenbruch. (In French.) — We do not object to that.

— Littera *C* is provisionally adopted subject to the sentence in question being struck out.

The President. (In French.) — We have concluded the examination of question X and will fix the definite wording of the conclusions at our meeting of Monday morning.

Communication.

The President. (In French.) — I call upon Mr. Watson to make a communication.

Mr. H. A. Watson, North Eastern Railway, England. — I wish to inform the meeting that the North Eastern Railway has for some time been making trials with an apparatus for repeating on the locomotive the track signals.

This apparatus, which is operated by means of electricity, consists of a brush made of steel wire and hung from the locomotive, which comes in contact with a copper bar placed between the rails, at a suitable height. This bar receives current from the signal. The steel wire brush is used to avoid any risk of breakage. The driver is warned by a bell when he is near the signal, and if this is standing at " danger ", this indication is repeated on the locomotive; if the signal is at " line clear ", this is equally indicated on a locomotive.

The apparatus also shows the driver what road he is to take at junctions.

This apparatus has been used above all on account of the fog which is frequent in November and in December, and it works so well that it has been decided to use it on a large scale.

Up till now it has only been used as auxiliary to the ordinary signals, but trials are being carried out in order to see if it is not possible to eliminate the other signals and only have that in the cab. It remains to be seen whether one can have absolute confidence in the latter.

I may perhaps be allowed to remind you that in England we have two signals, the distant and the home. The former is not absolute, but only gives the driver a preliminary indication; it tells him what the position of the second signal is. If it stands at " danger ", the driver knows that he must stop at the home signal.

The trials mentioned were carried out on locomotives hauling the fastest trains on this railway.

A similar apparatus is being tried on the Great Western Railway.

I invite the members of the Congress who come to England to see the good results obtained with this appliance, and I will be very pleased to show them how it works. (*Hear, hear!*)

The President. (In French.) — I think I express the feeling of the section in thanking Mr. Watson for his interesting communication.

Meeting held 11 July 1910 (morning).

The President. (In French.) — I call upon Mr. Weissenbruch to read the text of the conclusions drafted by agreement among the different reporters.

Mr. Weissenbruch, *reporter.* (In French.) — The following is the first paragraph, littera *A*, of the proposed conclusion :

" Although hand-operated apparatus are by far the most common and as a rule give satisfaction, the use of fluid-operated central apparatus has made rapid progress during the last ten years or so, particularly at very large stations. It has the advantage of allowing of greater concentration, and, consequently, of greater rapidity of operation, and, in some cases, of greater safety, while at the same time facilitating the work of the employees. It makes it at the same time possible to obtain very complete safety by arranging for the clearing of routes by the train, by indicating the true position of the points, by obtaining the return-to-stop position of the signals after the passage of the train, or in case of any disturbance in the route prepared, etc."

The new wording does not differ much from that provisionally adopted at the last meeting. There is a mere inversion of the terms " greater rapidity " and " greater safety ", so that one could not draw from the text a conclusion which is far from our thoughts.

On the other hand, apart from some trifling modifications, there are only the

words " in the route prepared " instead of " in the route run over ", in order to make matters clearer.

Mr. Descubes. (In French.) — I have just read through the text of the conclusion and I find that in spite of our efforts we have obtained no satisfaction as regards route-lever apparatus.

In fact the proposed conclusions imply that in case of break-downs the route lever does not give as much safety as the other devices.

Mr. Weissenbruch. (In French.) — It is now only a question of drafting and we are quite ready to modify the text and to indicate the reasons why in other countries one has not yet had recourse to the route lever. That, however, does not say that they will not use it in the future.

We were also told yesterday that there are now new apparatus which made it possible to obtain both the advantages of the route lever and those of the individual lever. It is clear that the conclusions do not apply to this.

Mr. Descubes. (In French.) — We shall in the end come to an understanding, but I repeat that the text as submitted to us implies that the route lever does not make regular operation possible if a switch is out of order. That is in complete contradiction with what we have said.

I am much surprised at this contradiction by the reporters who belong to a country where trials have not been made with the apparatus recommended by the French engineers.

Mr. Weissenbruch just said that there were new apparatus which made it possible to obtain at the same time the advantages of the route lever and those of the individual lever. I do not wish to enter into these details, for if it was necessary to discuss, even summarily, the motors and examine them one after the other, we would never come to an end. Some prefer the Siemens & Halske system, others the Siemens Brothers system, other again the Westinghouse system.

The point involves a question of principle.

As regards the report, it was unfortunately distributed under conditions which were unusual and contrary to custom.

Mr. Weissenbruch. (In French.) — I must protest. That is quite a mistake. Many other reports have had the same fate.

Mr. Descubes. (In French.) — I can but regret it.

However, that may be, the report must not be a piece of special pleading, traces of which are left in the conclusions.

We propose conclusions which are very moderate and are in a form containing no reflection upon anyone. I ask that they should be printed like the others.

Mr. Weissenbruch. (In French.) — Allow me to reply in two words to Mr. Descubes who asks that his proposals should be printed and distributed before they are discussed. I do not oppose this, but I must remark that this is not customary. The proposals of Mr. Descubes, if he so desires, will find their place in the report of the section.

My honourable colleague has also stated that our report was distributed under conditions which were contrary to rule.

Mr. Descubes. (In French.) — Under

conditions which were contrary to custom.

Mr. Weissenbruch. (In French.) — That is a complete mistake. For as I have already remarked when I answered Mr. Heurteau, similar cases of delay have occurred at every session. Messrs. Auvert and Mazen's report about electric traction was distributed at the Paris session in 1900 at a moment when the discussions had already commenced.

There have always been reporters who have been late and we have not been the only ones.

We cannot be reproached as having set an example to our colleagues who were as late as we were.

However, that may be, it is simply a question of coming to an understanding and to give an indication in the conclusions of the opinions which have been given during the discussion. Now Mr. Descubes proposes to introduce a paragraph describing the advantages of the route lever such as devised in the different systems of the French engineers. He also indicates the reasons why these engineers have with much ingenuity and cleverness, combined their apparatus.

As for us, we have limited ourselves to giving the reasons why this scheme has not been followed either in Belgium or in England or even in Germany.

I repeat, if our wording seems to you to be too absolute, we are ready to tone it down in order to show our wish for conciliation. I am, however, of opinion that our text contains nothing of a kind to be disagreeable to you.

Mr. Gérardin. (In French.) — What has complicated the situation, is the argument developped in Messrs. Weissenbruch and Verdeyen's report, and they have really expressed a personal opinion.

When we, Frenchmen, had read the report, we came to the conclusion that there was a desire to condemn the idea of the route lever. One reads, in fact, in that report that several French companies had again taken up the trials made in Germany in 1895 and given up since.

Under these conditions, we thought that we must leave no trace, in the conclusions, of what seemed to be implied by the report and that an idea which seemed practicable should not be condemned.

If the section would make a reservation of some kind, for instance say that it does not accept the argument set forth in the report, we could simplify the conclusions very much.

We admit that Belgium and Germany are not partisans of our route lever which is however in our opinion the solution of the future; but we ask that the conclusions should be preceded by the following words : " The section makes every reservation as regards the arguments set forth in the report ".

Mr. Weissenbruch. (In French.) — It is not necessary to say that the section makes reservations as regards the arguments set forth in the report, as the latter always reflects the personal opinion of the reporter and is binding only on him. The Congress is only responsible for its own conclusions.

If stress is laid on it, we will say that the report is the personal work of the reporters. That is however useless, as the word " section " must disappear after the decision at the general meeting. What we

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are preparing is only a set of proposed conclusions to be submitted to that meeting.

Mr. Descubes. (In French.) — The new wording of Messrs. Weissenbruch and Verdeyen's conclusions should be printed.

There are in fact many delegates present who are not as familiar with the subject as the reporters. One must at least have time to consider the words in order to be able to answer them, and this is difficult if they are merely read out.

Mr. Weissenbruch. (In French.) — We have no objection to the printing of the new text, so that everybody can examine it at leisure. We will accordingly take the measures necessary.

In order to save time, we might appoint a committee to draw up a text of a kind to satisfy everybody.

Mr. Descubes. (In French.) — Quite so, that is a good suggestion.

The President. (In French.) — That committee could meet at once and I propose that it should consist of the members of bureau and the reporters, together with Messrs. Tettelin, Descubes, Gérardin and Jullien. (*Approval.*)

Meeting held 11 July, 1910 (afternoon).

The President. (In German.) — Mr. Ulbricht proposes to bring forward a small correction in connection with the discussion of question X and proposes that it should be entered in the minutes. You will accordingly allow me to call upon him to speak. We will then pass to the discussion of the new proposed conclusions.

Mr. Ulbricht, *reporter.* (In German.) — At the last meeting, a Russian delegate remarked that my report did not devote enough attention to the installations used in Russia in many cases. He added that this was probably due to the Russian administrations having sent answers in late. I had an interview on this subject with the Russian delegates and I observed that the information in question had not reached me and hence could not be taken into consideration in my report. I wished to make this remark in order that it might not be thought that I had not sufficiently utilized, in my report, the information supplied.

The President. (In German.) — We will note Mr. Ulbricht's remark in the minutes.

I propose to pass now to the consideration of the definite conclusions drafted by the committee appointed this morning.

If everybody agrees, I will ask Mr. Weissenbruch to tell us the result of the deliberations of that committee.

Mr. Weissenbruch, *reporter.* (In French.) — " Littera *A*. — Although hand-operated apparatus are by far the most common and as a rule give satisfaction, the use of fluid-operated central apparatus has made rapid progress during the last ten years or so, particularly at very large stations. It

has the advantage of allowing of greater concentration, and, consequently, of greater rapidity of operation, and, in some cases, of greater safety, while at the same time facilitating the work of the employees. It makes it at the same time possible to obtain very complete safety by arranging for the clearing of routes by the train, by indicating the true position of the points, by obtaining the return-to-stop position of the signals after the passage of the train, or in case of any disturbance in the route prepared, etc.

" The methods of power supply used are electric current, compressed air with electric indicaling gear, and water under pressure. Purely electric, and electro-pneumatic installations are at present the more usual.

" In the case of isolated appliances, carbonic acid has been used with success.

" In very large stations, the concentration makes it possible to effect a saving by a reduction in the number of signalmen.

" In France, during the last few years, important applications have been made of apparatus with route levers. The end in view appears to have been attained under favourable conditions.

" In other countries at present no attempts are made to operate points simultaneously, other than those usually worked in combination for a cross-over; up to the present, the apparatus so designed seems to satisfy practical requirements.

" Both systems are good; but it is advisable to wait for further experience as to the advantages and disadvantages of these two systems.

" Central electric installations are operated by direct current. Single-phase current and three-phase current have also been used. Up to the present, some difficulties have been met with, among others the impossibility of utilizing accumulators as a reserve."

Mr. Tondelier suggests to me that it would be better, at the end of the seventh paragraph, to replace the words " of these two systems " by the words " of each of them."

This would evidently be better from the point of view of style.

Mr. Descubes. (In French.) — I agree.

Mr. d'Abramson. (In German.) — Just a few words about littera *A*. The sixth paragraph says : " In other countries at present... ". That seems not to be quite correct. In Russia, for instance, both the French system and the German-Belgian system are used. It would perhaps be better to say : " In most of the other countries at present..."

Mr. Weissenbruch. (In French.) — The text runs : " In other countries at present..."

Mr. d'Abramson asks that we should say : " In most of the other countries at present..."

I see no objection to the adoption of this amendment.

— Littera *A* is adopted as amended by Messrs. Tondelier and d'Abramson.

Mr. Weissenbruch. (In French.) — Here is littera *B*, as proposed by the special committee :

" Littera *B*. — Mechanical and electrical appliances are in use for locking the points while they are being run over

by trains. These arrangements, which should have a length at least equal to the greatest distance between axles, are not generally applied except in the case of points taken facing.

" On the Continent electric treadles, which can easily be made longer, have frequently been substituted for mechanical treadles.

" 2. Electric treadles are generally worked by means of a normally flowing current (' *courant de repos* ') interrupted by an economizer switch (' *contact d'économie* ').

" The points can be insulated without material difficulty.

" 3. The arrangements acting only after the last wheels have passed, enable all the points on a route to be interlocked up to the moment at which the train has entirely cleared the route. The use of these arrangements may be substituted for a series of locking bars at the points with economy."

The figures 2 and 3 which are in front of the third and fifth paragraphs should be struck out. (*Approval.*)

Mr. Descubes. (In French.) — A remark is made to me which is correct enough from the point of view of the French wording.

The third paragraph runs :

" Electric treadles are generally worked by means of a normally flowing current (' *courant de repos* ') interrupted by an economizer switch (' *contact d'économie* ')."

Clearly we all know what is meant by " *courant de repos* ", but it is not very correct.

Mr. Weissenbruch. (In French.) — It is a technical expression which I have found in a French book.

Mr. Descubes. (In French.) — It is however not used in France. The same applies to " *contact d'économie* ".

Mr. Weissenbruch. (In French.) — A " *courant de repos* " is a current which flows when the apparatus is at rest. If we were to say " *courant continu* " one would think that the apparatus was always at work.

Mr. Descubes. (In French.) — We always have an appliance for stopping the current whenever it is not required.

Mr. Weissenbruch. (In French.) — The German wording is clearer.

Mr. Descubes. (In French.) — Please note that we are really in perfect agreement.

I propose to adopt the following wording : " Electric treadles are generally worked so that the points are released by the flow of the current. The circuit is normally interrupted by an economizer switch."

Mr. Tondelier, *vice-president.* (In French.) — The fifth paragraph states :

" The arrangements acting only after the last wheels have passed, enable all the points on a route to be interlocked up to the moment at which the train has entirely cleared the route."

Now the interlocking is produced after the passage of the first axle and the unlocking after the passage of the last axle. That idea should be expressed in another way.

I accordingly propose that we should say ;

" Arrangements acting only after the last axle has passed, enable all the points on a route to be interlocked, from the moment the first axle has reached it till the moment the last axle has left it."

— Adopted.

— Littera *B* is adopted as amended by Messrs. Descubes and Tondelier.

Mr. Weissenbruch. (In French.) — Here is littera *C* :

" Littera *C*. — The use of a graphical method enabling the investigation of tracks at large passenger stations may be of very great service, particularly in the case of modification of the station arrangements."

— Adopted.

Communication.

The President. (In French.) — I call upon Mr. Weissenbruch.

Mr. Weissenbruch. (In French.) — Gentlemen, for several years the Belgian State Railway has made repeated trials in order to work out an appliance for warning the driver, in times of fog, of the position of the signals.

The first idea, due to Mr. Ramaeckers who was then general manager of the Belgian State Railway, consisted of warning the driver by audible signals placed along the track.

After rather long experiments with bell apparatus, which as might be expected gave negative results, we thought that detonators formed of a sporting cartridge and placed not on the rail, but to the side of it, would be able to give some warning to the driver.

We accordingly made trials with a device due to a French inventor, Mr. Cousin ; we placed them on the Brussels-Mons line 100 metres (109 yards) in front of the signal concerned, but we have not yet been able to find out how they work because there has been no fog since they were put in place.

This question is closely connected with that of the transformation of the signalling system by the adoption of a distant signal which may be passed when it stands at " danger ".

The Belgian railways still have, as a general rule, an " absolute stop " distant signal. They had decided to effect the change on the Brussels-Mons line, but this alteration has been postponed for reasons independent of the choice of the apparatus and it was found that the Brussels-Antwerp line had first to be altered. As the manufacturer could not supply the Cousin apparatus for this line sufficiently soon, we sought other devices.

At that time, there were several luminous repeating signals on trial at the entrance to Antwerp. We had the idea of making trials with these signals on a larger scale and we succeeded perfectly. A description of this system is given in the October number, 1909, of the *Bulletin of the Railway Congress*.

The lamps, three in number in front of the warning distant signal and two in number in front of the absolute stop signal, are placed at the level of the eye of the driver, and show changing colours, yellow and green ; yellow to indicate " stop further on " and green to indicate " line clear ".

The system gave perfectly satisfactory results during last winter, when there was much fog. The fast trains between Brussels and Antwerp were able to run as in ordinary weather.

We have, however, not finally adopted this device. We are still making experiments with an apparatus placed on the locomotive. This cab signal was devised by a Belgian inventor, Mr. César. It works by means of an electric current generated by a battery situated on the engine and short-circuited by a " crocodile ". The " danger " signal and the " line clear " signal are clearly indicated to the driver in the cab by an indicator and by sounding a compressed-air whistle.

We are going to make trials on the larger scale, on the Schaerbeck-Louvain-Liége line.

There is however an objection to this system.

It is feared that placing these devices on the locomotives — and Mr. d'Abramson also expresses this fear — will divert in time the attention of the driver from the track.

It is in order to counteract this disadvantage that in Russia the repeating signals are only used in times of fog. In order to meet this objection, it has been proposed to give notice on the locomotive only of the approach to the signal without indicating whether it is at " line clear " or at " danger ". I think experiments of this kind have recently been made in Germany.

The Snyers apparatus has been designed to satisfy this condition, and we have decided to try it. Its working depends on the mechanical action, on the locomotive, of a brush made with long steel wire, placed on the track.

To sum up, we have made numerous experiments, but we have not yet adopted a definite solution.

Mr. Descubes. (In French.) — As the point which Mr. Weissenbruch has just raised has turned up unexpectedly, I have not been able to bring the necessary papers and to deal with it in my turn. I will accordingly limit myself to giving some summary information.

Several years ago the French Eastern Railway placed a Cousin apparatus at a point near the Paris station, where the line used by the trains coming from the Ardennes and from Strasburg and the line used by the trains going to Mulhouse cross each other at a level. This crossing being frequently used, we have duplicated the distant signal by an extra warning signal.

For this purpose, we put in a Cousin detonator placing machine which until now has given us every satisfaction. It is a good apparatus, which up till now has given rise to no failure...

Mr. Weissenbruch. (In French.) — It is a very well-made machine.

Mr. Descubes. (In French.) — ... But it has the disadvantage of being very dear.

As regards the repetition of signals on the locomotive, we have tried, on the one hand, the Marin apparatus, on the other, the " crocodile " of the French Northern Railway, modifying it however quite appreciably. For two years we have been making experiments with this apparatus in the Ardennes, where fogs are rather frequent.

In this investigation, we have taken as our programme not only the operation of

an audible signal placed on the locomotive and acting when the disk signal in standing at " danger ", but also the recording, on the Flaman indicator, of the position of the signal, whether it stands at " danger " or " line clear ". One can ascertain in this way whether there have been too many failures of the appliance. These trials have given good results and failures have been comparatively rare. There are however still a certain number of failures, particularly when there is hoar frost and we have asked ourselves whether it is not advisable to have two brushes to each " crocodile ", one for removing the hoar frost and the other for the current. In a few months we are going to try gridiron " crocodiles ".

Mr. Weissenbruch said a little time ago that the Belgian railways intended to use the crocodile in times of fog only. I think as he does that from the point of view of the education and the strength of mind of the driver, it would be well to leave him in ignorance of the moment this device is set in action, so as not to dull his attention. However I doubt very much whether the State authorities will allow this. When we have started using the crocodiles in times of fog, six months will not elapse before we receive the order to use them always.

Mr. Weissenbruch. (In French.) — It is in order to meet this objection that the device on the locomotive should only show the proximity of the signal, but not whether it is standing at " danger " or at " line clear ". The signal on the locomotive will not tell the driver whether he can go on or whether he must stop, it will only tell him to pay attention.

Mr. Descubes. (In French.) — But we shall nevertheless be compelled to use it always.

It is certain that in the case of the Villepreux accident which occurred between 6 and 7 p. m. when the signal was still visible from a long way off, it is certain, I say, that if one had had crocodiles and had not had them in use the day the accident occurred, there would have been a general outcry against the administration. That is a side of the question which must not be lost sight of.

As for me, I am of opinion that we must all continue our investigations with the sincere desire of succeeding. We must not generalize the use of any given appliance before we have arrived at perfectly satisfactory results.

Mr. Weissenbruch. (In French) — What do you think of the solution which would consist of warning the driver of the proximity of the signal? How would the public receive this idea?

Mr. Descubes. (In French.) — I think it would be useful, in certain cases, to warn the driver of the proximity of a signal, even in clear weather. In fact when a signal is seen against a hill with woods and fields, it is seen with difficulty at certain hours of the day.

In order to draw the attention of the driver to the proximity of the signal, we have had some telegraph posts with rings which are alternately red and white.

Mr. Weissenbruch. (In French.) — We have applied a similar idea...

Mr. Dufour. (In French.) — The same in Holland. We have placed some boards, painted white, near the signal.

Mr. Weissenbruch. (In French.) — ... on the Belgian railways.

We have placed before the distant signal a series of five horizontal planks slightly inclined relatively to the axis of the track. The drivers are delighted with this arrangement which, I am personally convinced, will suffice to attract their attention.

These boards, placed at distances of 50 metres (55 yards) from each other, are marked with stripes and numbered in their order from the signal, so that if a driver suddenly perceives No. 3, he has only two more to pass.

Mr. Descubes. (In French.) — That is a continuous warning.

Mr. Weissenbruch. (In French.) — I have proposed this system and described it in the *Bulletin of the Congress* (1).

A delegate. (In French.) — Is this device such that it is of use at night?

Mr. Weissenbruch. (In French.) — Certainly; these boards are seen very well at night. The head light of the locomotive lights them up, as they are near the track.

A delegate. (In French.) — Some day you will be compelled to light them up.

Mr. Weissenbruch. (In French.) — We have made some very interesting trials in the way of replacing these boards by slightly-curved enamelled plates which are very visible at night. At first sight one does not believe this possible, but the evidence of the experiments is conclusive. The drivers are well satisfied with this installation.

(1) See *Bulletin of the Railway Congress*, November, 1902, p. 912.

Mr. Descubes. (In French.) — It is understood, of course, that the warning signal on the locomotive acts, whether the signal stands at " danger " or at " line clear ".

Mr. Weissenbruch. (In French.) — Certainly.

Mr. Dufour. (In French.) — In Holland, the Dutch State Railway has placed on some lines, before the home signals, at a distance of 850 metres (930 yards), warnings consisting of three boards about 5 metres (16 ft. 5 in.) long. These boards are painted white, are gently inclined and are placed about 10 metres (11 yards) apart at a height above rail-level, which increases from 1·50 to 3 metres (4 ft. 11 in. to 9 ft. 10 in.)...

Mr. Weissenbruch. (In French.) — We place them at the height of the head light.

Mr. Dufour. (In French.) — ... but the drivers say they do not see them.

Mr. Weissenbruch. (In French.) — That, I think, is because the height of those boards goes on increasing. Our experiments have shown that they should be placed at the height of the head light of the locomotive.

Mr. Maison. (In French.) — It is feared that a repeating signal placed on the locomotive will finish by dulling the vigilance of the driver. Differences of opinion may exist about a question of this kind.

I think however that I must remark that the railway industry is not the only one in which the use of automatic devices for compensating for any want of attention of the employees has been considered. A

case may be found in the mining industry, for instance where for a long time automatic stops have been provided at the pit heads in order to prevent any overwinding in the case of want of attention of the employee in charge. These installations have not dulled the attention of the employees and have eliminated a serious cause of accidents. One does not see why the same should not be the case with appliances for repeating the signals on the locomotives.

It seems very necessary, in my opinion, taking the present state of railway operation into consideration, to have appliances on the locomotives to show the drivers the position of the signals. It is because as a matter of fact, during the last few years, the conditions under which trains run have become modified. The locomotives, which have become more powerful, have become larger, and the driver is placed in a less favourable position to observe the signals from a distance. Moreover, speeds have increased materially. A very ordinary speed is 30 metres (98·43 feet) per second. Ten seconds are required for 300 metres (328 yards); that is often the whole distance over which a signal can be seen. Then a moment of inattention of the driver, a momentary neglect, any occurrence on the locomotive distracting the attention of the driver for a few moments, suffice, in case of an unfortunate coincidence, to keep the driver from seeing the signal, and a serious accident may occur.

Accordingly I think, in spite of the objections of principle frequently raised against devices for repeating signals, that safety will be materially increased by the use of these devices not only in times of fog, but also in clear weather, that is to say, if they are taken into ordinary everyday use.

Mr. Weissenbruch. (In French.) — If a warning device is placed on the locomotive in accordance with the idea we have just been discussing, the driver will be warned of an approaching signal and hence he would be obliged to notice it; if necessary a device can be added to check whether the driver has been warned or not.

The President. (In French.) — The remarks just exchanged are very interesting. They will be reproduced in the verbatim report.

DISCUSSION AT THE GENERAL MEETING

Meeting held on 16 July, 1910 (morning).

MR. P. WEISSENBACH, PRESIDENT, IN THE CHAIR.

GENERAL SECRETARY : MR. L. WEISSENBRUCH.

FIRST ASSISTANT GENERAL SECRETARY : MR. MÜRSET.

SECOND ASSISTANT GENERAL SECRETARY : DR. A. BONZON.

Mr. Kareischa, *principal secretary of the 3rd section*, read, the

Report of the 3rd section.

(See *Journal de la huitième session*, No. 11, p. 7.)

" The reporters, Messrs. DUFOUR, ULBRICHT and VERDEYEN, gave a summary of their report. Mr. Carter, reporter for America, was not present.

" On the proposal of Messrs. JULLIEN (*Orleans Railway*) and VERDEYEN, it was decided not to discuss hand-operated apparatus. The Permanent Commission was requested to insert this interesting question among the agenda for the next session of the Congress. It was then agreed to take as basis for the discussion, the conclusions proposed by Messrs. Weissenbruch and Verdeyen, which were drafted in such a way as to include the whole of the question, and to which Dr. Ulbricht agreed subject to some modifications in the wording.

" MR. ULBRICHT had recently received some supplementary information from the Swedish State Railway in answer to question 16 of the detailed list of questions contained in his report. This information would be inserted as an appendix to the verbatim report of the discussion.

" Mr. MAAS-GEESTERANUS (*Dutch Railway Company*) gave some information on the electric and electro-pneumatic apparatus in use in Holland. He stated that he had made some very satisfactory experiments with the latter.

" MR. PETRI (*German government*) drew attention to question 59 of Mr. Ulbricht's reports, referring to the question of warning the driver, independently of the signals. He desired to know what experiments had been made on this point in other countries.

" Mr. D'ABRAMSON (*Russian State Railway*). In reply stated that an apparatus for repeating on the locomotive the track signals had been in use on the Russian South Western Railway during the last few years. But it was only used on exceptional occasions (thick fog, snow, etc.), so as not to dull the attention of the drivers. The apparatus gave good results.

" Mr. WEISSENBRUCH (*reporter*) observed that Mr. Ulbricht had dealt with this question because the reporters had always been given the greatest liberty in widening the scope of any question. He himself, and also Mr. Carter, had not given such a wide interpretation to the question. He was however ready to give some information on the subject, if the President thought this desirable.

" Mr. ULBRICHT suggested that this important point might form the subject of an exchange of opinions.

" Mr. PETRI also urged that some information should be given on this point.

" THE PRESIDENT proposed to postpone this till after discussion of littera C of the conclusions.

" Mr. DESCUBES (*French Eastern Railway*) then addressed the section. He thought that Messrs. Weissenbruch and Verdeyen's report criticized the route apparatus very severely, the more so as these apparatus, which were in use only in France, were mostly not sufficiently well known to the reporters. It was incorrect that the French engineers had repeated the trials made in Germany fifteen years ago; their work had been absolutely original. The term " recent trials " could also not be applied to systems which had shown what they were capable of at Valenciennes, at Nancy and at Bordeaux, and at the last station during seven years already. According to the report, it would seem that the Bordeaux apparatus had been copied from an apparatus patented by the firm Siemens and Halske, and this the reporters could certainly not have meant; now Mr. Bleynie had obtained for his apparatus a patent in Germany.

" The French engineers had above all tried to increase the capacity of the cabins, to simplify the operation and to facilitate the work of the signal-men under all conditions; the possibility, in case of a strike, of letting the first-comer operate the levers was only an additional advantage.

" Mr. Descubes also remarked that the apprenticeship at the ordinary signal-cabins was not so negligible, as the reporters themselves estimated it at two or four weeks. Now at Nancy, not even a whole day was necessary before the signal-men thoroughly understood the operations and were able to increase the station output.

" In case of failure, the cutting-out of one appliance could be effected without hindering the service or reducing the safety.

" As far as the saving of time was concerned, this was by no means illusory. Mr. Descubes quoted some figures in support of this and remarked that in cabins with separate levers and route interlocking, all the levers corresponding to the switches concerned had to be operated in addition.

" The objection raised in France, that the route levers prolonged the time needed for operation, also applied to all the appa-

ratus (German or Belgian) in which route-completing treadles were used; this disadvantage could however be remedied.

" As regarded cost of working, this was about the same as regarded maintenance and supply of power, whether route levers or separate levers were used; but in the case of large signal-cabins it was possible in certain cases to reduce the cost of staff with the first system. Thus in the case of a signal cabin on the French Eastern Railway, now under consideration, 187 levers would be required in the case of a Saxby frame; Mr. Descubes thought that with the newer apparatus in use in Belgium, 265 levers or handles would be necessary; with the Nancy system, 64 levers would suffice.

" Messrs. Weissenbruch and Verdeyen could not admit that their report " criticized very severely " the French apparatus. In recalling the trials made in Germany in 1895, and given up, they only intended to quote history and evidently had not desired to dispute the originality of the French apparatus. What they said about the Bleynie system was only a summary of a passage in the note describing the Antwerp installation, published in 1904 in the *Bulletin of the Congress*.

" The term " recent trials ", to which Mr. Descubes took exception, occurred on page 172 of the offprint (1), in the second paragraph. It referred, if one compared it with the last paragraph of the preceding page, solely to the Descubes system, at Nancy, and to the M. D. M. apparatus experimentally installed at the Paris station of the French Northern Railway.

(1) See also the *Bulletin of the Railway Congress*, No. of August-September-October, 1910, p. 3439.

" The reporters who had been to see the Bordeaux (Bleynie) apparatus in 1909 and the Paris-Nord (M. D. M.) apparatus in 1910, found the same advantages in separate electric levers without the complicated construction which resulted from operation by a single lever.

" The apprenticeship of the signalmen at Alost had been as short as at Nancy. They had been taught, in advance, the plan of the station, the location of the switches and how these were numbered. But it had not been possible for them to enter the cabin till twenty-four hours before it was taken into use; nevertheless there had been no case of delay of any train.

" In case of a break-down of a switch operated separately, the regular operation of the central apparatus could be continued and the mechanical interlocking in the cabin continued to be in action. In exceptional cases one could even refrain from using any special safety appliance.

" The last and quite recent type of route-lever apparatus, the M. D. M. exhibited at Brussels, where devices were used making separate operation possible normally, seemed no longer liable to this objection.

" In order to appreciate the difference of output of the two systems, two identical instances had to be taken. In this case, the difference was reduced to the time necessary for operating the switch levers, a time of but little importance when each of these levers was operated in one operation.

" As for Mr. Descubes's statement, that 187 Saxby levers, which could be replaced by 64 Descubes levers, would require 265 levers or handles with the apparatus in use in Belgium, the reporters could affirm with certainty that they would be

able to reduce this figure of 265 very materially by utilizing all the resources of the Belgian system. In the applications made in Belgium, they had also succeeded in reducing the number of electric levers as compared with the number of Saxby levers. At Alost, 144 electric levers did the work of 381 Saxby levers.

" Mr. HEURTEAU (*Orleans Railway*) regretted that Messrs. Weissenbruch and Verdeyen's report had not been distributed earlier and that Mr. Bleynie had not been able to answer it and eventually be present at the meeting.

" Mr. WEISSENBRUCH also regretted his inability to issue his report sooner. As he had already mentioned, what he had said about Mr. Bleynie's system he had already published six years ago in the *Bulletin of the Congress*. Other reports had also been late and the secretarial offices of the Congress had given them priority. The same thing had happened at other sessions. At Paris, in 1900, Mr. Auvert's report had only arrived after the opening of the session.

" Mr. TETTELIN (*French Northern Railway*) remarked that the reporters themselves admitted that the route-lever system was not inferior to the Belgian or German system. The fundamental idea of the route-lever appeared to be misunderstood, and the separate lever was only a stage in arriving at it. The new apparatus in actual use on the French Northern Railway gave every satisfaction and it was to be regretted that Messrs. Weissenbruch and Verdeyen's report contained remarks which cast doubts on the future of that system.

" Mr. Tettelin laid a description of the new apparatus on the table.

" The REPORTERS took note of Mr. Tettelin's statement that the new apparatus did not exist when they drew up their report; their remarks therefore did not apply to this apparatus which it would be a pleasure for them to examine.

" Mr. JULLIEN asked that the hydro-dynamic apparatus which had been used for the last twenty years on the Orleans Railway, without break-downs, should also be mentioned in the conclusions, and that one should not at once give preference, over the electro-pneumatic apparatus, to the purely electrical apparatus. He did not notice, as clearly as Messrs. Weissenbruch and Verdeyen, any marked preference in the American report in favour of electrical apparatus.

" Mr. DMITRENKO (*Russian State Railway*) stated that in Russia the Bianchi-Servettaz system had been used with success, in spite of the great variations in the temperature, which might amount to as much as 75° C. (135° Fahr.); and sometimes the minimum temperature was 35° C. below zero (—31° Fahr.). On the other hand, good results had not been obtained with apparatus using liquid carbonic acid.

" Mr. SEGRÈ (*Italian State Railway*) supported Mr. Jullien's conclusions and stated that in Italy the principle of the hydro-dynamic apparatus had also been applied since, and that with success.

" Messrs. ULBRICHT, DUFOUR and JULLIEN proposed some further modifications in the wording of the proposed conclusions, and Mr. VERDEYEN read revised conclusions

amended in accordance with the results of the discussion. Messrs. Gérardin (*French Eastern Railway*) and Jullien had assisted in this revision.

" As regarded littera *B*, Mr. Tettelin, acting for Mr. Jullien, made a communication on the subject of a new mechanical locking treadle, 12 metres (39 ft. 4 in.) long, which had been tried on the Orleans Railway during the last few months; it worked very smoothly and appeared to be giving excellent results.

" Mr. Descubes stated that the electric locking treadle was frequently used on the French Eastern Railway; he mentioned however that in certain cases it was necessary to increase the length of these devices to 36 metres (118 feet), and this could be done without difficulty with electricity.

" Mr. Verdeyen (*reporter*) then read the conclusions referring to littera *B* and to littera *C*. Messrs. Descubes and Motte (*Belgian State Railway*) supported the modifications in the wording, which had been proposed in agreement with Mr. Ulbricht.

" Mr. H. A. Watson (*North Eastern Railway, England*) mentioned an interesting apparatus which was being tried on the North Eastern Railway for repeating in the engine cab the track signals. He invited any members of the Congress to come to England to see the good results obtained with this apparatus and expressed his readiness to show them how it worked.

" Mr. Weissenbruch (*reporter*) gave a short account of the experiments made in Belgium with warning appliances on the track and on locomotives, to be used in cases of fog. After having experimented without success with bells, the administration of the Belgian State Railway decided on making a trial, on the large scale, of Cousin's detonating apparatus, placed on the track 100 metres (109 yards) in advance of the distant signal to be passed. The apparatus were in place, but there had not yet been any fog. Another trial had been made between Brussels and Antwerp; an account of it had been published in the *Bulletin of the Congress* for October 1909. Five lamps were placed at the height of the eye of the driver; particulars were given in the appendix to Mr. Motte's report (1) on subject III (junctions). The results were excellent. Means for making such installations under economical conditions which would allow their extended application were now being investigated. Finally it had just been decided to try between Schaerbeek and Liége the César locomotive-cab apparatus, which indicated the " line clear " and " danger " positions of the signal electrically by means of a kind of treadle.

" It was also under consideration to try apparatus which merely warned the driver that he was approaching the signal, in order not to distract his attention from the track, which should be his chief duty.

" To sum the matter up, the Belgian State Railway was not yet in a position to recommend any definite solution.

" Mr. Descubes gave some information about the trials made by the French Eastern Railway for the last two years. The position of the signals, whether off

(1) See *Bulletin of the Railway Congress*, March, 1910, p. 1271.

or on, was marked on the tape of the Flaman recorder, and one could detect all failures with certainty. The number of the latter was by no means negligible, particularly in winter, and it was advisable to wait till one had obtained more satisfactory results, before adopting any apparatus generally.

" After some more remarks, especially by Mr. TONDELIER (*Belgian State Railway*), the following conclusions were adopted for submission to the general meeting."

The President. (In French.) — The following are the

CONCLUSIONS.

LITTERA *A*.

" Although hand-operated apparatus " are by far the most common and as a " rule give satisfaction, the use of fluid- " operated central apparatus has made " rapid progress during the last ten years " or so, particularly at very large stations. " It has the advantage of allowing of " greater concentration, and, consequent- " ly, of greater rapidity of operation, and, " in some cases, of greater safety, while " at the same time facilitating the work of " the employees. It makes it at the same " time possible to obtain very complete " safety by arranging for the clearing of " routes by the train, by indicating the " true position of the points, by obtaining " the return-to-stop position of the signals " after the passage of the train, or in case " of any disturbance in the route pre- " pared, etc.

" The methods of power supply used " are electric current, compressed air " with electric indicating gear, and water " under pressure. Purely electric, and " electro-pneumatic installations are at " present the more usual.

" In the case of isolated appliances, " carbonic acid has been used with suc- " cess.

" In very large stations, the concentra- " tion makes it possible to effect a saving " by a reduction in the number of signal- " men.

" In France, during the last few years, " important applications have been made " of apparatus with route levers. The end " in view appears to have been attained " under favourable conditions.

" In most of the other countries at " present no attempts are made to operate " points simultaneously, other than those " usually worked in combination for a " cross-over; up to the present the appa- " ratus so designed seems to satisfy prac- " tical requirements.

" Both systems are good; but it is " advisable to wait for further experience " as to the advantages and disadvantages " of each of them.

" Central electric installations are oper- " ated by direct current. Single-phase " current and three-phase current have " also been used. Up to the present some " difficulties have been met with, among " others the impossibility of utilizing " accumulators as a reserve."

LITTERA *B*.

" Mechanical and electrical appliances " are in use for locking the points while " they are being run over by trains. These " arrangements, which should have a " length at least equal to the greatest " distance between axles, are not generally

" applied except in the case of points " taken facing.

" On the Continent electric treadles, " which can easily be made longer, have " frequently been substituted for me- " chanical treadles.

" Electric treadles are generally worked " so that the points are released by the " flow of the current. The circuit is nor- " mally interrupted by an economizer " switch.

" The points can be insulated without " material difficulty.

" Arrangements acting only after the " last axle has passed, enable all the " points on a route to be interlocked, " from the moment the first axle has " reached it till the moment the last axle " has left it. These arrangements may in " many cases be substituted, with econ- " omy, for a series of locking bars at the " points."

LITTERA *C.*

" The use of a graphical method ena- " bling the investigation of tracks at large " passenger stations may be of very great " service, particularly in the case of modi- " fication of the station arrangements."

— These conclusions were confirmed by the general meeting.

APPENDICES

APPENDIX I

[656 .257 & 656 .21 (01] —

Note of the administration of the Swedish State Railway in answer to question 16 of the list of questions of Mr. Ulbricht, author of report No. 1.

Our answer to question 16 of the list of questions relating to the operation of switches and signals having been mistranslated, we have the honour of stating it precisely in the lines which follow, leaving it to you to use them, as you may see fit, at the next session of the Congress at Berne.

This question runs as follows : *Have you any arrangements on your systems in which a given position of the switch lever releases the switch, so that it can be operated locally?*

In answering that we use apparatus of this kind rather extensively, we wished to say that provision is made that the switch can be operated locally when the switch-lever is in the *normal position* or in the *thrown-over position*, but not, as stated on page 42 of the report (1), that the switch lever has three different positions and that when it is in the middle position the switch is released so that it can be operated locally. The apparatus in question are probably intended for this purpose, but those which we use have the following arrangement.

The switch handles or levers are of the same type as those for switches operated from a distance *only* and which can be cut open when the lever is in the normal position or in the thrown-over position. In the case of wire transmission, a special lever is used which is interlocked for the local operation. When the switch is operated locally, the effect is the same on the switch handle or lever, as when the switch is cut open by a train.

As a general rule, a locking pulley must be used with these switches operated from a distance and locally, in order to prevent local operation when the main signal in standing at line clear, for with the existing types the switch lever is cuttable when the route lever is in the thrown-

(1) See also *Bulletin of the Railway Congress*, January, 1910, p. 334.

over position. The same is not the case for the switch handle; however, the locking pulley is considered necessary for switches taken from the facing side.

These apparatus are used by us rather extensively. At small stations, where a single central frame suffices, the switches which have to be operated for the combination of the different routes are arranged, so that they can be operated from the cabin, and those of the switches which have to be operated during train movements, are also arranged so that they can only be operated locally. Thanks to this organization, a single employee looks after the service of the signals and switches, when trains cross and pass each other. As regards shunting operations, they do not require the presence of a signalman in the cabin, as all the switches concerned can be operated locally.

Installations of this kind have been adopted since 1896 at about one hundred and ten stations and at present fifteen others are being equipped in this way; they have been recognized, from the economic point of view, to be the most advantageous for little stations where trains cross each other.

KLEMMING.

Stockholm, 1 July, 1910.

APPENDIX II.

[656 .257 & 656 .21 (01] —

Note on the M. D. M. system. Installation in cabin XI (Landy), Paris-Nord,

By Anon.

General observations.

The operation and controlling of the working of points and signals from a distance by means of power supply, such as compressed air, fluid under pressure or electricity, has now become a necessity in railway working.

It has become, in fact, necessary to increase the safety of the ordinary systems, to supplement the muscular energy of the operator, and to make the performance of the operations more rapid without increasing the number of signalmen.

To meet these requirements, cabins have been fitted with route levers. In such cabins all those details which represent the routes taken by the trains have been grouped in the first instance in the design and construction and are operated by a comparatively small number of interlocked levers.

Usually it is necessary to move a number of these levers in a certain definite order to clear a train. Such a system is necessarily complicated. Its execution requires lengthy study since it is necessary, in order to be prepared for all contingencies, to provide for numerous combinations in addition to those normally required.

In the tangle of electric leads and pipes only a specialist knows what to do. On the other hand, the signalmen do not realize exactly what function they perform and their attention is generally taken up by the levers instead of being directed to the track.

Finally, should a modification suddenly be found necessary which has not been provided for, it is difficult to deal with it because it is impossible to change entirely, in a few minutes, the grouping and interlocking which have been arranged.

It is therefore necessary to use makeshift und uncertain arrangements over a period of time which is always too long when safety has to be considered.

In the M. D. M. system, an endeavour has been made to eliminate all complication. With this object, while realizing the idea of the route lever or key which is found desirable by the traffic department,

the principle of individual levers is retained because this is the simplest, the clearest and the only system which lends itself to all combinations.

The characteristics of the M. D. M. system are as follows :

1° Each point or signal is represented individually in the cabin;

2° Operation at one movement and by means of a single key, of the point and signals of each route.

All the sets of points are operated simultaneously and the route is made in the shortest possible time.

The signalman is therefore free to devote his whole attention to watching the tracks;

3° Route keys grouped in a " combiner" occupying but small space arranged as a " Table of Pythagoras " which is easy to read, and no training is required to understand it;

4° Interlocking effected immediately on operating and permitting of all combinations being made without either preliminary study or arrangement;

5° Positive and permanent indication of the position of the points, keeping the signal always in agreement;

6° Permanence of the interlocking so long as the signal is not set to danger (signal indicator) or so long as the train is still within the zone operated from the cabin (transit).

Characteristic features of the M. D. M. system.

I. *Mechanical route combiner.* — The mechanical combiner is the appliance in the cabin which effects the characteristic methods of operating enumerated above.

It is the combiner which selects from the individual details, corresponding to the various points and signals, those combinations necessary for making the route and securing the interlocking.

The combiner is of rectangular shape. On the front it carries the references which the signalman may require to use and also the knobs or handles of the route keys.

There is one key for each route.

The same key is used for traffic in either direction.

In their neutral position the keys stand at 45°.

To make a route, it is only necessary to perform the operation of turning its key to the vertical or to the horizontal position according to the direction in which the route is to be used.

The keys are arranged in rows at right angles to each other, in which the horizontal rows refer to arrival tracks and the vertical rows to departure tracks or *vice versa*. The whole forms a " Table of Pythagoras ".

To make a route to connect an arrival track with a departure track, it is sufficient to look at the column and row referred to, and to turn the key which occupies their point of intersection.

To render the table more easy to read, the rows and columns are numbered. Each key is designated by the number of its row and of its column.

Thus the key 43, for example, is the key for that route which connects the arrival track represented by the row 4 with the departure track represented by the column 3.

Each row or column carries at its extremity an indicator signal showing the position of the signal giving access to the corresponding track.

When a route is made the key is turned towards the indicator of the signal to be pulled off.

The selection of the key and the direction in which it is to be moved are therefore capable of being grasped by anyone without special knowledge.

On the inside of the combiner, the points and signals are represented by metal planes parallel to the face of the board.

There is one plane for each set of points (point plane) and one plane for each arrival or departure track, either with or without a signal (track or signal plane).

The keys are perpendicular to the front face of the board and run through the combiner from front to back, passing consequently through all the planes.

When a key is required to control a plane it is fitted with a cam acting on that plane, otherwise it is without.

The cams are of two kinds, point cams and signal cams.

They present the following features:

1° When the key which carries them is in the neutral position the cams do not bear against the planes which are quite free;

2° When the key is turned they are displaced and then hold either to the right or to the left planes of which the corresponding sets of points are to be moved to the right or to the left;

3° Each plane so held, to the right for example, prevents the turning of any other key the rotation of which would tend to bring it back to the left.

The routes are therefore interlocked among themselves, because the sets of points common to both cannot be worked from two opposite sides at the same time.

All the interlocking arrangements between the routes which cannot be made simultaneously with safety, are thus effected naturally and without special gear (1).

This result applies generally. It is independent of the plan and of the arrangement of the routes, whether the points are for simple crossings, double slip points, or cross overs. It is obtained without scheming, since it depends on the one fact that any particular plane, that is to say, any one set of points, cannot occupy positions to the right and to the left at the same time.

The interlocking preventing traffic from running in opposite directions over the same route is even more simple: a single key cannot occupy both vertical and horizontal positions at the same time; hence it is not possible to make a route in two opposite directions at the same time.

It is this fact which explains the statement that *in the M. D. M. system no scheming for the interlocking is required.*

It follows that with the mechanical combiner of the M. D. M, system any change can be effected *immediately*.

By changing the number and position of the cams of a key, the plan of the route it controls can be modified as desired.

By the addition of a key a new route can be made with any of those existing, and this can be done without troubling about the interlocking involved by the operations, irrespective of their number and arrangement.

So far, in the description of the combiner, nothing has been said of the way in which the planes are connected with the points and signals to which they correspond. Any kind of power supply can be used for the transmission.

We shall not discuss here the arguments which may decide the selection of one kind of power supply rather than of another. We shall confine ourselves to stating that in the applications already made, or being installed, hydraulic power is used (glycerine being added to the water in winter) in the case of transmission of force to a

(1) Tracks which cross each other are treated similarly to points; this is, however, unnecessary where there is a loop track.

distance, and compressed air at low pressure is used as the motive power.

The water acts the part of a connecting rod between the combiner and the motors.

This transmission of power by fluids is economical, free from risk of short-circuit, and has the advantage that its efficiency can be checked directly by the natural senses.

The pressure used for the hydraulic portion of the system is about 8 kilograms per square centimetre (114 lb. per square inch). The air is compressed to from 5 to 10 kilograms per square centimetre (71 to 142 lb. per square inch) in a receiver. It is used at a reduced pressure, about 3 kilograms (43 lb. per square inch), for operating the points and signals. It is also used for the supply of water under pressure, by means of a simple and compact ram which acts as a hydraulic accumulator, permanently at full lift.

It will be seen that in the M. D. M. hydro-pneumatic cabins, the only power to be supplied is the compressed air. The Aster Company have constructed very small compressors for this purpose, of particularly simple and strong construction, requiring practically no maintenance and capable of being run direct by electric motors or paraffin oil engines.

In the event of failure of the compressors a locomotive fitted with a compressed air brake can be brought up to the cabin and used temporarily.

Finally, if no locomotive is available, the motors at the points can be worked by hand, independently of the power supply.

II. *Controllers.* — By this term are understood those appliances which show that the point blades are home against the stock rail and also show the position they occupy in relation to that of the planes which represent them in the cabin.

The control of a route is effected by sending hydraulic pressure through a pipe to the departure end of the route and passing this to each set of points of the route in the opposite direction to that which will be taken by the train, that is to say, it is supplied first to the end of the route which the train will leave, and last to the end at which it enters.

When the pressure reaches the entering end, it returns thence to the cabin and operates the signal. Thus it is the pressure in the control pipe which throws over the signal.

In the cabin, the outward flow and return of the pressure in the control pipes is effected as follows :

It has been shown above that each of the tracks entering and leaving is represented in the combiner by a plane. On turning the key corresponding to a route, the planes corresponding to its entering and leaving tracks are simultaneously moved. The displacement of the plane corresponding to the leaving track admits the pressure to the control pipes which are laid along the route which it follows as already explained.

The displacement of the plane corresponding to the entering track admits the pressure in the control pipe to the entering signal of the route, when it has completed its travel along the track.

Between the leaving track and the entering track the pressure in the control pipes travels as follows :

Each set of points is fitted with a *controller*, which is a sort of valve, open when the points are home *in the direction to which they have been set* by the combiner, and only for the period of operating, being closed in all other cases.

When the valve is open the pressure is admitted. When the valve is closed, on the other hand, it cannot pass and the

Fig. 1. — Cabin XI at Landy. French Northern Railway; entering Paris.

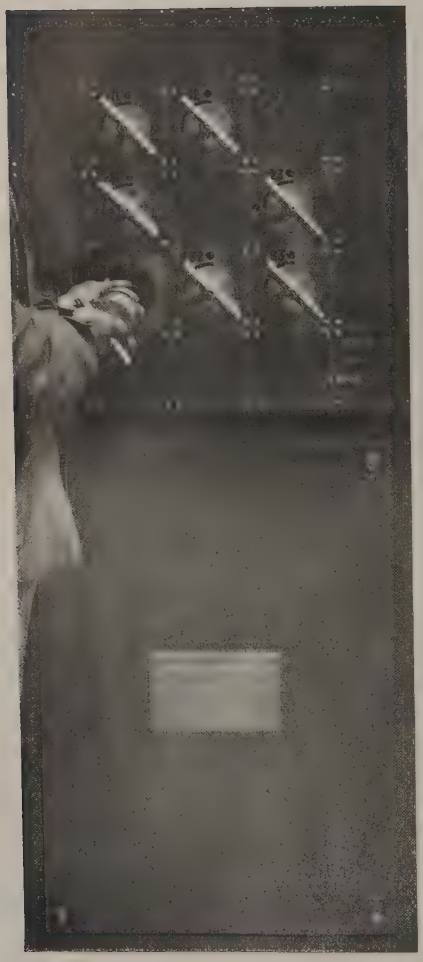

Fig. 2. — Front of the auto-combiner.

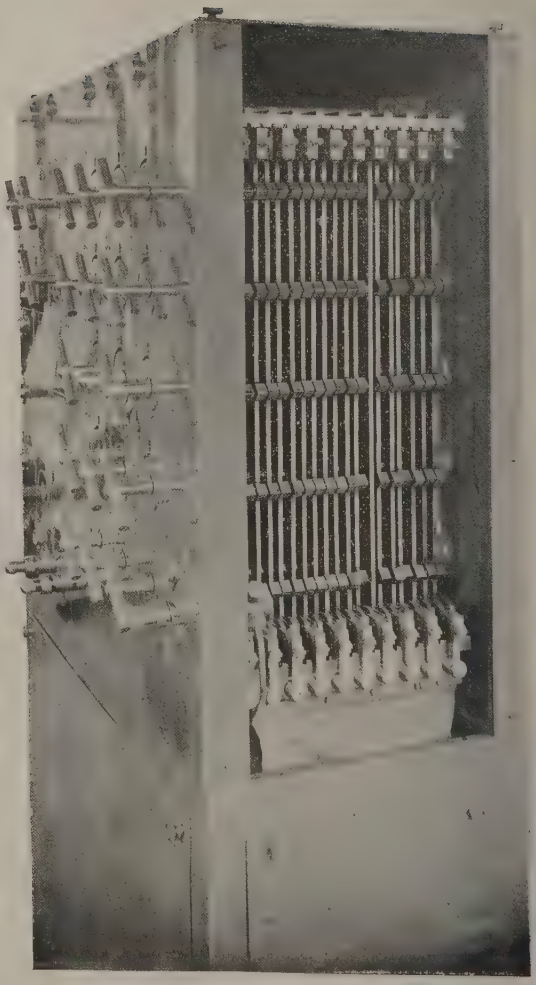

Fig. 3. — Side view of the auto-combiner.

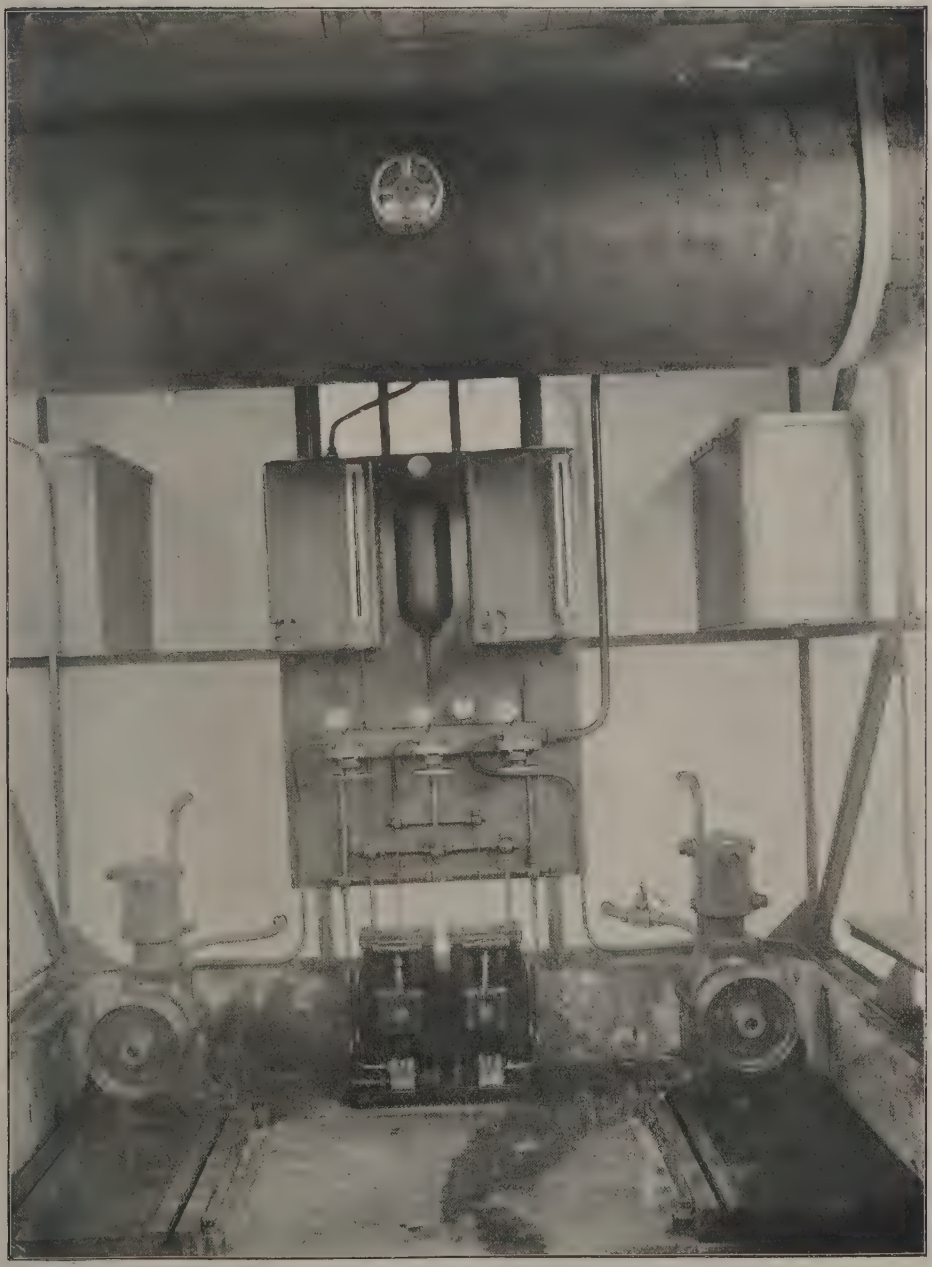

Fig. 4. — Power supply and storage (compressed air).

Fig. 5. — Operating by hand in the event of a failure in the power supply.

Fig. 6. — Controller for a set of points interlocked with positive and permanent control.

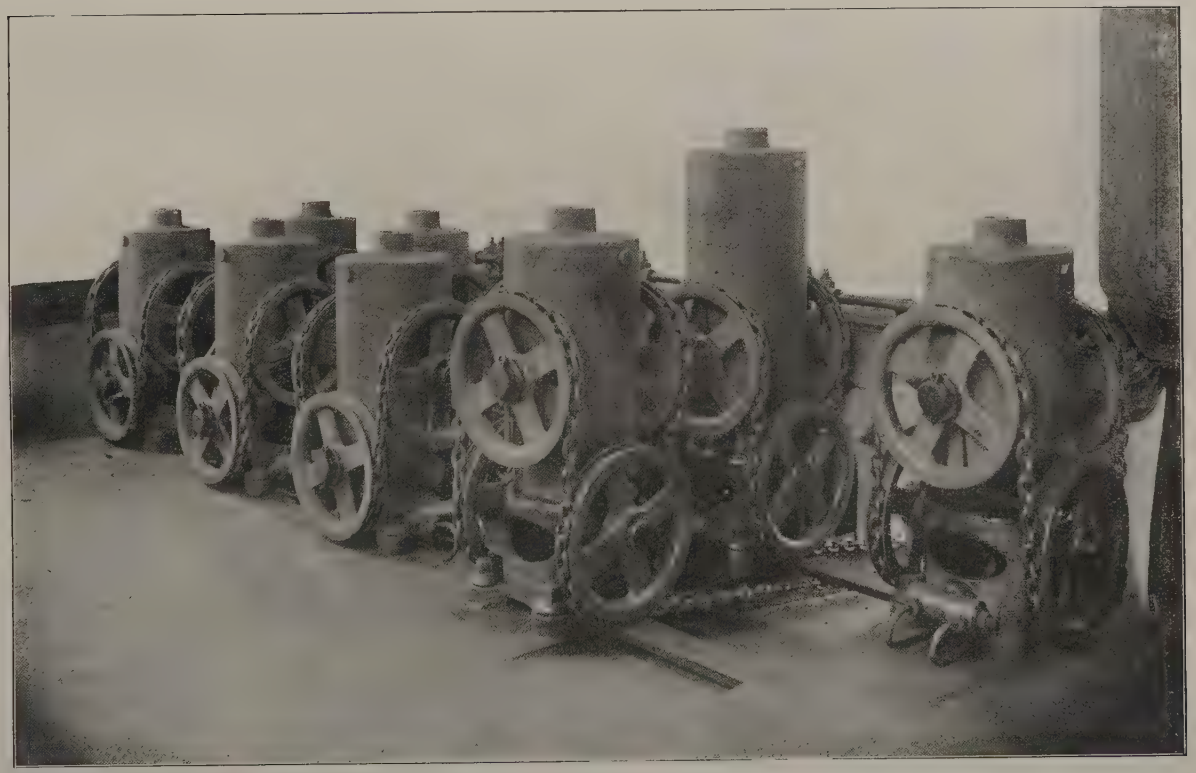

Fig. 7. — Controller for signals which are operated by wires.

Fig. 8. — Signal controller carried on the post.

Fig. 9. — Auxiliary controller attached to rigid rodding.

signal at the entrance to the route remains at danger. The controllers represent the points and the intermediate pipes represent the tracks. The control is consequently an exact representation of the system of tracks.

It follows that the control pressure on being admitted to the controllers of a set of points is transmitted thence to the next and thence to the next, and so on, thus completing the route.

If a set of points does not occupy the desired position, it stops the transmission of the pressure and the signal is not pulled off. If at any time and from any cause whatever anything goes wrong, the pressure ceases to be transmitted and the signal returns to danger.

To sum up : in order that the entering signal of a route may occupy the line-clear position it is necessary that :

1° The key corresponding to this route should be turned in the proper direction;

2° That the points along this route should each be thrown over fully or held fast and that the point tongues should be home against the stock-rails.

The control is therefore positive and permanent.

There are some points worthy of notice in this method of controlling :

1° If the pressure in the control pipe finds a continuous passage enabling it to connect the leaving and entering ends of the route, then the tracks also give a continuous route ready for the train to enter;

2° From the fact that a set of points cannot simultaneously be set to the right and to the left, a natural form of interlocking is afforded on the tracks, obtained from the position occupied by the points, of a similar character to that given by the planes in the combiner, which correspond to the respective points and in fact it is a kind of duplication of this; this amounts to the same thing as stating that it is just as impossible to obtain simultaneously from one set of points (1) on the track the control of routes which would form an unsafe combination as it is impossible to transmit from the combiner in the cabin controls which in combination would be unsafe.

This property of the system, taken in conjunction with the individual character of the operating gears, enables the most complex routes for connecting entering and leaving tracks to be made at once, even without the route keys. This is a valuable advantage in cases of alteration to the tracks or of sudden change in the method of working.

The control is sometimes supplemented by an electrically-operated indicator board in the cabin, which shows the tracks and the position of the points. This apparatus is merely an indicator. It has no action on the position occupied by the points or signals.

III. *Signal controllers.* — It is important that the return of the route key to its normal position, and the consequent release of the interlocking arrangements, should not be possible before the signal controlled by that key has been actually set to danger. The signal controller effects this in the following manner :

Every signal when at line clear practically locks the track plane which set it to line clear.

The key, which was turned to cause the clearing of the route, is capable of being

(1) When two tracks cross without connecting points, a controller is arranged at the crossing which acts in the same manner as if the crossing were a set of points.

turned through an angle sufficiently large to ensure the return of the signal to danger. It cannot, however, complete its rotational movement until the track plane has been freed, that is to say until after the signal has completely and actually returned to danger.

The movement of returning a route key to its normal position when this controls its signal must necessarily be performed in two steps:

First step: partial rotation of the key, signal returns to danger;

Second step: completion of the rotation of the key, freeing of the interlocking arrangements.

IV. *Transit. Block system.* — The transit is a form of interlocking which prevents the route key from being returned to normal from the moment the train has entered the section operated from the cabin until the last pair of wheels has cleared the section.

To ensure this, the train itself locks the plane of the combiner corresponding to the leaving track so soon as it enters the route and it only releases it when it leaves the route.

The connection between the entering and leaving tracks is fixed by the combiner, by the position occupied by the key itself, that is to say at the intersection of the row which corresponds to the entering track with the column which corresponds to the leaving track.

To the transit is sometimes added the block system. In this case, the signal cabins adjoin the rows and columns of the combiner. The keys when turned couple them in pairs.

Usually this connection is all that is required, but in some cases the setting of a signal arm to line-clear causes a key connecting two cabins to be locked.

V. *Backing down.* — The routes over which backing down operations are effected are generally incomplete. They are however true routes, and, for this reason they are provided for in the general scheme of the M. D. M. system. Under these circumstances the solution of the problem presented by backing down, does not require any special consideration apart from those already set forth.

VI. *The M. D. M. auxiliary controller.* — In the first application made of points-controllers of the M. D. M. system in 1907 at the Cabin A at Landy, some of these were connected to the points by rigid rodding of considerable length.

The regularity with which they operated, under special conditions, led to the idea of using them "to ease the heavy pulls" in cabins fitted with Saxby apparatus.

The connection is made in the following manner:

The points-controller is placed at the base of the cabin and is connected rigidly to the rodding.

An M. D. M. transmitter is fitted adjacent to the Saxby lever, to which it is coupled by a strap-ended connecting rod.

Two fluid connecting rods are employed between the transmitter and the controller, the one for bringing to normal position and the other for throwing over.

The mode of operating is as follows:

When the lever in the cabin stands in its normal position, the points and the controller which are rigidly connected to it by the rodding, are normal also.

If the lever is moved from the normal position, the controller comes into action at once and assists the operations until the lever is thrown completely over and the points are also thrown over.

In the converse movement, the control-

ler acts in restoring the points and the lever to the normal position.

By varying the air pressure admitted to the M. D. M. auxiliary controller the force exerted by it can be increased or diminished.

The M. D. M. auxiliary controller can therefore, at will, only give assistance to the signalman, or on the other hand, can of itself perform the operation as rapidly as may be desired,

Should the pressure fail, the signalman can move the Saxby lever just as though no auxiliary controller were fitted.

SECTION III : WORKING

[656 .234] QUESTION XI

PASSENGER TICKETS

Different types of passenger tickets. Systems enabling the number of blank tickets to be reduced. Simplified tickets for stopping places. Apparatus for printing tickets (and checking them) as and when required.

Reporter :

All countries. — President von Zluhan, director, chairman of the administrative Department of the Wurtemberg State Railway.

QUESTION XI

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N. B. — Vide also the separate issue (in red cover) No. 18.

(1) Mr. von Stierlin has died since sending in his report.

[656 .234]

REPORT

By Mr. von STIERLIN,

PRESIDENT OF THE MANAGING COMMITTEE OF THE GENERAL ADMINISTRATION OF THE WURTEMBURG STATE RAILWAY.

The object of this question, on which I have to report, is supply members of the International Congress with information on the subject of the different ticket systems at present used by the railway administrations of the different countries and thus to show what alterations and improvements have been made as compared with former times.

The discussion of this subject appears to me very advisable for the following reasons :

1° The continual increase in the passenger traffic on the one hand, and economic reasons on the other, make it necessary that the dispatch of passengers should be quick and simple, and that at the same time abuses should be prevented as much as possible. It is therefore to the advantage of every administration, to examine the ticket system of other large administrations, in order if possible to benefit by it;

2° The continued growth in the traffic in the different countries is always making new demands on the railway administrations, from the point of view of the fares charged for the conveyance of passengers. As a result, the necessity from time to time arises, of changing the fares or of introducing new tariffs, and this also involves corresponding changes in the existing patterns of tickets used, or the issue of new tickets.

In order to carry out my work, I have in accordance with the wording of the question (Passenger tickets : Different types of passenger tickets. Systems enabling

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the number of blank tickets to be reduced. Simplified tickets for stopping places. Apparatus for printing tickets [and checking them] as and when required.) drawn up a list of questions and sent it to seventy-five of the more important railway administrations in the different countries. Fifty-seven of these administrations sent replies.

I think I can best describe the conditions existing by giving a summary of the answers received to the individual questions. In addition I have prepared, from the specimens sent to me, a typical collection of tickets of different patterns which I will exhibit at the Berne Session.

REPLIES TO THE VARIOUS QUESTIONS.

QUESTION 1. — *Of what shape are the tickets you issue, and of what material are they made?*

The information collected shows that tickets are everywhere made of card or of paper, of different colours and shapes. The ordinary shape of a card ticket is that of the so-called Edmonson ticket (about $57 \times 30{\cdot}5$ millimetres [$2\,{}^{1}/_{4} \times 1\,{}^{3}/_{16}$ inches]). Among paper tickets we may mention book tickets and books of tickets, *i. e.* tickets bound in the form of books with a stiff or a limp cover. The separate pages are either coupons for the different sections of the journey or tickets for a given journey (tickets for a given number of journeys over one and the same section). In the case of season tickets, linen paper is frequently used because it is more durable.

Besides the rectangular shape which is the most usual, we have to mention tickets of octagonal shape, used in France, South Africa and Australia, and tickets of oval shape, used in France and in Australia.

Besides card and paper, the following materials are also used for tickets :

Leather, for season tickets in England, France, Austria-Hungary and Australia.

Metal, for season tickets in Australia. These metal tickets (annual tickets, partly of gold) are of round or of oval shape (about 25 to 35 millimetres [1 to $1\,{}^{7}/_{16}$ inches]); and are made to hang on. The section for which the ticket is available is indicated by letters or numbers.

One peculiarity of American tickets is that some of them are printed on very long strips of paper; I have received specimens up to 139 centimetres (4 ft. 6 ${}^{11}/_{16}$ in.) long by 7 centimetres ($2\,{}^{3}/_{4}$ inches) wide (apart from mileage coupon books).

Question 2. — *Are tickets of different shapes issued? If so :*

a) What were the reasons for the individual shapes?
b) What shape of ticket is most used?

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a) Germany : In the case of journeys at the ordinary tariff rates, particularly in the home traffic of the individual administrations, Edmonson tickets are used, which are made of a standard shape for technical, traffic and economical reasons, as well as for the convenience of passengers. All other shapes are on account of special clauses in the tariffs and of provisions in connection with the accounts and controls, or on account of agreements with other administrations; for instance in the case of season tickets, it was necessary to adopt a larger size as more had to be printed on them, and in order to distinguish them more readily from the other tickets. The tickets which may be used at the passenger's option for varied routes on different railways are issued either as books of tickets or as Edmonson tickets with a piece to be cut off for purposes of control.

England : The different shapes are intended to define the nature of the tickets; each kind of ticket is to have a special character.

France : The shape of the tickets is dependent on agreements made between the French railways with a view to the through traffic.

Italy : The conditions under which the tickets are used, the statements which have to be found on the tickets, such as the route to be followed, the record of where the journey was interrupted, etc., have led to the use of tickets of different shapes.

Holland, Russia : The different shapes of the tickets are dependent on the different tariff regulations.

Austria-Hungary : The reasons for the different shapes were the convenience of use, considerations as regards control (for instance, when several administrations are concerned), local requirements, as well as the amount of printing which had to be on the tickets (for instance, in the case of season tickets).

Switzerland : The Edmonson tickets are the simplest and the most rational; the reasons for the other shapes were : facilitating the control and the settlement of the accounts.

North America : The shapes are suited to the conditions under which the tickets are issued. Where there is much traffic, card tickets are used, as these are easier to manufacture and to issue than the simplex tickets.

The other administrations questioned give similar answers.

b) According to the answers received, the Edmonson card ticket is everywhere the shape of ticket most used.

Besides the Edmonson tickets, the following were mentioned :

Dutch State Railway : kilometre books.
Hungary : paper tickets.

QUESTION 3. — *If special tickets (express tickets, return tickets, circular tickets, season tickets, etc.) are issued for certain trains or for special purposes, please send us a list of the different kinds issued.*

Germany : Besides the tickets which are available for all trains, and which have a longitudinal red stripe on them, the following are issued : tickets for express and passenger trains, double tickets (the one half is collected when the single journey is completed, the other serves for the return journey), return tickets to the seaside places on the coasts of the North Sea and the Baltic; mixed tickets (tickets with imprint available at different stations, to which the fare is either the same or different); excess tickets for express trains; soldiers' tickets; tickets for special trains; Sunday tickets; continuation tickets; children's tickets; sleeping-berth tickets; excess tickets for transfer to a higher class; workmen's weekly tickets for single journeys and also for return journeys (the latter are available for 12 journeys; at each journey a hole is punched through the ticket at the corresponding numbered spot. Besides these, there are also workmen's weekly tickets in Wurtemburg and Baden, which in order to accelerate the control are not punched at the ticket barrier. They are available for one week; the weeks in the year are numbered successively, and the corresponding number is stamped in large and clear figures on the ticket; (in weeks where there are one or more holidays tickets are issued available for five or four days); workmen's return tickets; workmen's monthly tickets; circular tickets; books of tickets made up in various combinations; tickets of the tourist agencies; season tickets, for periods of from 1 to 12 months; monthly tickets; monthly supplementary tickets; pupils' tickets; tickets to watering places; summer tickets; soldiers' passes; passes for special trains, and special carriages; passes for school excursions; tickets for men accompanying live-stock carriages; dog tickets.

Belgium : Return tickets available to one of more stations (tickets for one given station are issued to stations with much traffic or if the receipts from these tickets have to be divided with private railways; tickets available to several stations are used, in order to simplify the work of the ticket clerks, and to reduce the number of the blank tickets which have to be written out; three destinations can be printed on one ticket); tickets for parties, for emigrants, for excursions and for tourists; circular tickets; season tickets for 5 days and 15 days, and for 3, 6, 9 and 12 months,

available on all the Belgian lines; season tickets for 3, 6 and 12 months available on a given line only; pupils' tickets for 3 and 6 months, and for the academical year; workmen's weekly tickets for the single journey and for the return journey (these tickets are of two kinds, 7-day tickets, available from Sunday to Saturday inclusive, and 6-day tickets, available from Monday to Saturday inclusive).

Bulgaria : Return tickets; circular tickets; books of tickets made up in various combinations; season tickets.

Denmark : Ferry tickets; excess tickets; circular tickets; monthly tickets available between certain stations or on all lines; fortnightly tickets available over the whole of the State Railway; emigrants' tickets; books of tickets made up in various combinations; station tickets, available for one uninterrupted journey on a passenger train or on a mixed train to the station, or to one of the stations, indicated on them. In addition, between stations 30 kilometres (18·5 miles) apart, as well as on other sections with much traffic, tickets are issued, which are available either for a single uninterrupted journey on the train for which they are taken, or which may be used, in the opposite direction, for trains which start before midnight of the day on which they are issued (these tickets are shortly to be replaced by return tickets without reduction of rate).

England : Return tickets; children's tickets; excursion tickets; soldier's tickets; sporting tickets; seaside tickets; tickets for commercial travellers, emigrants, tourists; Sunday tickets; market-day tickets; workmen's tickets and workmen's weekly tickets; tickets available from Saturday to Monday or from Saturday to Tuesday; circular-tour tickets; tickets for special trains; season tickets available on given sections for periods of from 1 to 12 months.

France : Mixed tickets; soldiers' tickets; return tickets; tickets for visiting watering places; tickets for pilgrim trains and excursions trains; emigrants' tickets; tourist tickets; racing tickets; family return tickets; workmen's tickets and workmen's weekly tickets; circular-tour tickets, books of tickets made up in various combinations; season tickets for 1, 3 and 12 months; books of tickets for 20 journeys on a given section; dog tickets.

Italy : Return tickets; express tickets; supplementary tickets; circular-tour tickets (in order to avoid the necessity of having different kinds of these tickets, some of them have a separate section for each class, first and third, in different colours; and a separate section for each of three different tours; by removing the class and tour sections not required in a given case, the ticket is prepared for the class and tour desired by the passenger); book of tickets made up in various combinations; season tickets of several kinds, ordinary, pupils' and special (the latter are available on given sections for 15 or 30 days, 3 months or a year).

Holland : Return tickets; Sunday tickets; soldiers' tickets; tickets for D-trains

and for excursion trains; market tickets; tickets for parties; emigrants' tickets; cyclists' tickets; workmen's weekly tickets; holiday tickets for July, August and September; workmen's holiday tickets; circular-tour tickets; books of tickets made up in various combinations; pupil's tickets; tickets for 10 journeys on a given section; kilometre books (each journey is entered on the different pages; the departure and the arrival stations are mentioned, and also the distance; the distances are added up from time to time); season tickets.

Norway : Tickets for journeys on the local trains; single tickets and return tickets (these tickets are used where the rate for several different sections is the same); mixed tickets for single as well as for return journeys (several stations with different rates are designated on the tickets; the tickets are cut through at the station of destination; the part with that station on is issued to the passenger, the other is kept by the ticket clerk); children's tickets; excess tickets; family tickets; monthly tickets; workmen's tickets in books of 12 tickets (weekly tickets) and in books of 50 tickets (monthly tickets); circular-tour tickets; tourist tickets; books of tickets made up in various combinations; sleeping-berth tickets; dog tickets.

Austria-Hungary : Return tickets; tickets for special trains; half-price tickets; express tickets; supplementary tickets for express trains; combined tickets (available by express train on part of the journey and by ordinary train on the other part); soldiers' tickets; Sunday tickets; tourist tickets; tickets to watering places; excess-fare tickets; servants' tickets; workmen's tickets and weekly tickets; tickets for reserved seats; sleeping-berth tickets; books of tickets made up in various combinations, season tickets for 6 and 12 months on all lines (in small cases with the photograph of the passenger stuck in); pupils' tickets; tickets for a given section (when these tickets are issued, they are cut through below the number of months, for which they are available; the cut-off upper part is stuck on the back of the photograph of the holder); subscription tickets for travelling if half the fare is paid (in a small case with photograph); season tickets available for 15 and 30 days on certain given sections; passes for soldiers' and for civilians; passes for men accompanying corpses, animals and other consignments.

Rumania : Return tickets; tickets for visiting watering places and health resorts; children's tickets; soldiers' tickets; tickets for excursion trains, for the Orient express, the Ostend express and the Berlin express; circular-tour tickets; books of tickets made up in various combinations; season tickets for the whole railway system or for part of it, and available for 1, 3, 6 or 12 months (in the form of a book, with the photograph of the holder); excess tickets on the trains.

Russia : Suburban tickets; express tickets; return tickets; zone tickets; mixed tickets for different stations with different fares; excess-fare tickets; tickets for pilgrim trains; tickets for reserved seats; season tickets.

Sweden : Double tickets; express tickets; tickets at reduced fares; soldiers' tickets; excess-fare tickets; sleeping-berth tickets; stopping tickets; special-train tickets; monthly tickets; tickets for 20 journeys between given stations; passes for military transports; books of tickets made up in various combinations; tickets for the tourist agencies.

Switzerland : Return tickets; tickets at half price; tickets for change of class; supplementary tickets for travelling by a longer route; workmen's tickets; Sunday tickets; tickets for pilgrim trains; circular tour tickets; singles and returns to the Bernese Oberland; control checks for party tickets, school tickets and kilometre books; tickets for the agencies in London and Paris; books of tickets made up in various combinations; tickets for tourist agents; tickets for parties and schools; supplementary tickets, station and train staff; excess tickets of train staff; tickets for extra charge for express trains on foreign sections (in Switzerland itself there is no extra charge for express trains); emigrants' tickets; tickets for English parties; workmen's monthly tickets; season tickets, for 24 single journeys and for 12, 25, 50 or 100 double journeys on given sections; season tickets available on all trains given in the timetable; pupils' tickets; season tickets fort wo members of the same firm; general season tickets (with photograph of holder stuck on) for 15, 30 and 45 days, 3, 6 and 12 months; general season tickets for two persons for 12 months; kilometre books (these parate pages are divided into 1 kilometre (0·62 mile) sections and the photograph of the holder is stuck on).

Spain : Return tickets; family tickets; mixed tickets; children's tickets; soldiers' tickets; excess-fare tickets; supplementary tickets; circular-tour tickets; kilometre books; season tickets.

United States of America : Return tickets; special-train tickets; excursion tickets; tickets for trains consisting of Pullman cars only; circular-tour tickets; tourist tickets; season tickets available for one ore more months; tickets for 10, 25, 50, 55, 60 or 100 journeys between given stations; mileage books for 500 miles (the separate pages are divided into 20 sections of a mile each); mileage books for 500, 1,000 and 2,000 miles (these are printed on long strips of paper divided into sections of 1 mile or of 5 miles; a stiff cover is provided). Then we also have to mention the so-called simplex, multiplex and lomax tickets; their object is to avoid having too many printed tickets. They are made of paper; a number of destination stations are printed on them. The destination of the passenger is marked in the case of the simplex and lomax tickets by a cut which corresponds with the part remaining at the station; in the case of multiplex it is marked by putting in perforations above and below the name of the destination station.

Argentine Republic : Return tickets; excursion tickets; workmen's tickets; week-end tickets, (issued on Saturdays, Sundays, feast days or the day before; the return journey is made on Monday, or on Tuesday if the Monday was a holiday. The

tickets issued on feast days and on the day before are available on the next working day after the feast day); excursion tickets; holiday tickets on special occasions such as the Carnival, Easter, Christmas; season tickets for 1, 3, 6 and 12 months; zone tickets for railway employees.

Mexico : Return tickets; mixed tickets; circular-tour tickets.

India : Return tickets; tickets for the servants of first and second class passengers; workmen's tickets; tickets for markets and fairs; pilgrim tickets; troop tickets; tourist tickets; tickets for standing room; tickets for limited trains; circulartour tickets; monthly tickets.

Egypt : Return tickets; mixed tickets; books of tickets; season tickets.

South Africa : Return tickets; children's tickets; family excursion tickets; season tickets; books of tickets for 20 journeys over given sections; mileage books (the pages are divided into small sections of 1 mile each).

Australia : Simplex tickets with the names of several destination stations printed on (they are used on sections, where there are many stations without booking offices, and are issued on the train; they save many blank tickets and excess-fare tickets); tickets for excursion trains; excess tickets for going on beyond the destination station of the ticket or for changing from one class to another; circular-tour tickets; excursion tickets; pupils' tickets; season tickets for 1, 3 and 12 months either for all the lines, or for given sections only.

QUESTION 4. — *Are your tickets kept ready printed at the booking offices, or are also printed forms provided which the ticket clerk has to fill up in writing in each separate case (blank tickets)?*

In Denmark all the tickets are supplied ready printed to the stations, the monthly tickets are issued chiefly by the head office.

All the other administrations have at their stations not only ready-printed tickets, but also blank tickets (tickets on which certain forms are printed, and on which the booking clerk has to fill in the destination station, the route and the fare). The French Northern Railway is, as an experiment, trying at one of its booking offices a machine for issuing blank tickets. This was constructed by the firm « l'Appareil Contrôleur » in Paris and resembles the machine used for printing Edmonson tickets (compare question 14).

QUESTION 8. — *If blank tickets are used, please inform us :*

a) In what cases are they issued ?

b) How is their issue controlled and checked ?

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a) In *Denmark* no blank tickets are at present issued. In all other countries they are issued .

1° In the case of connections with but little traffic, for which there are no printed tickets;

2° Instead of printed tickets, if the supply of these happens to have become exhausted.

In addition, blank tickets are used by some administrations for the purpose of excess-fare tickets if a passenger travels beyond his destination station or changes into a superior class.

The rules as to how much traffic there must be before ready-printed tickets for a given journey are supplied vary considerably in the different countries. The following information is collected from the answers of several administrations. Ready-printed tickets are supplied in the following countries if the minimum issued per year is not less than :

Germany	12 to 25	Spain	600
Belgium	25 to 36	U. S. A.	180
England	4 to 50	Argentine Republic	25 to 36
France	12 to 144	India	12 to 50
Holland	120	Egypt	24
Rumania	60	Australia	25 to 36
Russia	20		

b) In most countries, the tickets are issued from duplicate books, the original being kept by the station while the passenger receives the carbon as ticket, or else the blank ticket has a section which has to be filled in like the ticket and is retained by the station for the control after the ticket has been separated from it. These stubs are sent together with the accounts to the controlling office, and checked there. The blank tickets of some administrations (for instance in Austria and in the United States) have a third section which is collected by the conductor when the journey is begun and which is also sent to the controlling office. In addition, the blank tickets are collected by the conductors at the end of the journey and are sent to the controlling office, which compares them with the accounts of the stations. As check that no ticket is sold out of the proper order, there are the consecutive checking numbers printed on them like on the other tickets. In cases when the blank tickets have no special sections for purposes of control (ordinary Edmonson tickets as in Belgium, Holland, India, Egypt, Australia; partly also in England,

France and Norway), the control is effected merely by the checking numbers and by a comparison of the tickets with the accounts of the stations.

The *Italian* blank tickets consist of a piece of card or of paper. On the one side there are the tens, on the other side the units of the lire, placed one under the other (fractions of lire are not given). When the ticket is used, the card is cut at the points corresponding to the price of the ticket in such a way, that the fare is shown. The passenger receives the one part as his ticket, the other part is retained by the issuing stations as check. If part were subsequently cut off from both parts of the ticket, the fare shown would be altered and would be increased on the part retained by the station and reduced on the other part.

In *Rumania*, the blank tickets consist of two Edmonson tickets joined together; on them are printed the name of the issuing station and also the price of the ticket in whole francs; the booking clerk has only to enter the class, the destination station and the centimes. There are 60 different blank tickets, from 1 to 60 francs (from 9·6*d.* to £2.8*s.*); the latter amount is the highest which can occur. The one ticket is detached by the booking clerk and serves as check.

In India there are in some cases different blank tickets for distances of up to 100 miles, from 101 to 250 miles, from 251 to 500 miles, and over 500 miles.

Question 6. — *Are you taking any steps, other than supplying printed tickets, for reducing the number of blank tickets?*

Question 7. — *If so, please give us particulars of these steps.*

Germany : Several passengers travelling together to one station can be booked by one single blank ticket (also adults and children together), namely four first-class, six second-class, and eight third and fourth-class. In the case of blank tickets for soldiers, there is no limit to the number which can be booked by one ticket. In the case of school excursions, one joint blank ticket is used.

France : Parties (musicians, members of scientific excursions, etc.) receive one joint ticket.

Austria-Hungary : Parties belonging together and consisting of more than 6 members receive one joint ticket.

The provision that several persons can be booked by one single blank ticket also exists, to judge by the sample tickets sent, in England, France, the United States, the Argentine Republic and South Africa.

Among such devices we must also include the mixed or group tickets mentioned under question 3. On these tickets the names of several destination stations, to which the fare may be the same or may be different, are printed; in this way the

stocking of ready-printed tickets for each separate destination station or the issue of blank tickets is avoided. Such tickets exist in Germany, Belgium, Denmark, Norway, Russia, Spain, the United States, Mexico, Egypt and Australia.

Question 8. — *Are special tickets necessary for admission to the station if no travelling tickets are taken?*

In the following countries special tickets are always necessary for admission to the station if no travelling tickets are taken :

Germany, Belgium, Bulgaria, Italy, Austria-Hungary, Spain, Egypt.

In the following countries, such special admission tickets are not necessary at all stations, but only at certain definite, generally larger, stations :

Denmark, England, France, Holland, Norway, Rumania, Sweden, India and Australia.

In the United States, there are only veryfew instances of the issue of special tickets for admission to the stations.

Such special tickets for admission to the stations are not issued in the following countries :

Switzerland, Argentine Republic, Mexico; and at present also Russia where however such tickets are shortly going to be issued.

In South Africa, such special tickets are only issued to hotel servants.

Question 9. — *If so, please send us some specimens and inform us :*

a) Whether the tickets are only available for one admission to the station?

b) Or whether season tickets are also issued and under what conditions?

c) What is the charge for a ticket?

d) Are such tickets issued free and if so in what cases?

Germany : a) Yes, and on the day of issue only. In some cases the regulation exists that tickets issued between 11 and 12 o'clock at night are still available next day.

b) Season tickets are not issued.

c) 10 pfennigs (1·2*d.*).

d) Free tickets for admission to the platforms are issued to persons who have business relations with the railway administration; to persons who must have access to the trains for delivering or fetching goods (particularly milk); in the case of some managements, to members of the Press, to persons who are employees of

the workmen's or women's protection societies, or who look after destitute emigrants, etc.

The following are admitted free of charge, without special tickets, to the platforms :

1° The employees of the railway administration, on duty.

2° The officials of the office of the public prosecutor, the courts of law, forestry and police; the post-office, telegraph, customs and revenue officials, if this is necessary for carrying out their duties on the railway; they must either be in uniform or produce an order from their superiors.

e) Persons who have business with any of the post offices or railway offices within the barrier.

d) The contractors at work within the barrier and their men.

Belgium : a) Yes, the tickets are only available for two hours.

b) No.

c) 10 centimes (0·96*d.*).

d) No. Certain officials are however allowed admission free of charge; some of them receive special passes.

Bulgaria : a) Yes.

b) No.

c) 10 centimes (0·96*d.*).

d) Admission is only free to the railway employees on duty.

Denmark : a) to *c*) There are tickets for one single admission (price 10 öre [1·34*d.*]), and season tickets for 3 months (price 2 kroner [2*s.* 3*d.*]; a deposit of 50 öre [6·72*d.*] has also to be made).

d) Yes, to certain local, civil and military officials; to persons who are authorized to trade, etc., when the trains arrive and leave; to servants of those hotels which send carriages every day to the station.

England : a) Yes.

b) No.

c) and *d*) In some cases free, in others 1*d.*

France : a) Yes, the tickets are only available for two hours.

b) No.

c) 10 centimes (0·96*d.*).

d) No, but the station officials are authorized to admit certain persons without tickets.

Italy : a) to *c*) There are tickets for one single and tickets for several admissions.

AVAILABILITY OF THESE TICKETS.	1st class stations, price.	2nd class stations, price.
Single admission	20 centimes (1·22*d.*).	10 centimes (0·96*d.*).
20 times, available for 2 months . .	3 lire (2*s.* 2 1/2 *d.*).	1·5 lire (1*s.* 2 1/2 *d.*).
40 — — — 6 — . .	5 — (4*s.*).	2·5 — (2*s.*).
80 — — — 12 — . .	8 — (6*s.* 5*d.*).	4 — (3*s.* 2 1/2 *d.*).

d) No.

Holland : a) to *c*) Tickets for one single admission (price, 5 and 10 cents [1 and 2 pence]), available for one hour only, and season tickets :

1° For 6 months, price 5 florins (8*s.* 4*d.*) Dutch Railway Company);
2° 12 — — 10 — (16*s.* 8*d.*) — — —
3° 12 — — 5 — (8*s.* 4*d.*) Dutch State Railway).

d) Admission free, if one desires to see the station master. Certain hotel servants and employees of tourist agencies receive free passes.

Austria-Hungary : a) to *c*) There are tickets for one single admission (price 20 heller [2 *d.*]) and season tickets for periods of one month and one year. Price of the tickets for one month, 3 to 4 kronen (2*s.* 5*d.* to 3*s.* 2 1/2 *d.*); for one year, 20 to 36 kronen (16*s.* 8*d.* to £1.10*s.*).

d) Tourists agencies and officials receive free passes.

Norway : a) to *c*) There are tickets for one single admission and also season tickets. The price varies at different stations :

Single admission . .	5 to 10 öre (0·67 to 1·34*d.*).
1 month	1·25 to 6·00 kronen (1*s.* 5*d.* to 6*s.* 9*d.*).
3 months	3·75 to 12·50 — (4*s.* 2 1/2 *d.* to 14*s.*).
6 —	6·00 to 25·00 — (6*s.* 9*d.* to £1.8*s.*).
12 —	10·00 to 50·00 — (11*s.* 2 1/2 *d.* to £1.16*s.*).

d) Representatives of the national committee for fighting the white slave trade are admitted free on proof of identity. The police has free admission to all the places to which the public is admitted. Porters and messengers awaiting the arrival of trains also have free admission.

Rumania : a) Yes.
b) No.
c) 20 bani (1·92*d.*).
d) No.

Russia : a) Yes.
b) No.
c) 10 copecks (2·88*d.*).
d) No.

Sweden : a) Yes.
b) No.
c) 10 öre (1·34*d.*).
d) No.

Spain : a) to *c*) Tickets for one single admission. (Price : 0·10, 0·25, 0·50 peseta [0·96*d.*, 2·4*d.*, 4·8*d.*]); tickets for 30 admissions (price : 7·50 pesetas [6*s.*]); season tickets for one year (price : 25 pesetas [£1]);

United States of America : a) Yes.
b) No.
c) 1*d.*

India : a) to *c*) Tickets for one single admission (price : $^1/_2$ anna [$^1/_2$ *d.*]) and season tickets for 3 months (price : 5 rupees [6*s.* 9*d.*]).
d) Reception committees of religious societies, etc., in some cases receive free passes.

Egypt : a) to *c*) Tickets for one single admission (price : 0·5 piastre [1·25*d.*]) and season tickets for 1 year (price : 50 piastres [10*s.* 5*d.*]).
d) Only to high officials.

South Africa : a) No.
b) and *c*) Monthly and quarterly season tickets. The price varies; as a rule it is 10*s.* or £1.

Australia : a) to *c*) Tickets for one single admission (price : 2*d.* to 3*d.*) and season tickets for hotel servants, 3 months, 7*s.* 6*d.*, 6 months, 12*s.* 6*d.*; 1 year : £1 at larger stations and 10*s.* at smaller stations.
d) No.

The platform tickets for one single admission are with hardly an exception card tickets of the Edmonson pattern. In the case of some railways the numbers 1 to 12 are printed on for the hours (a. m. and p. m.) in order to be able to check, by a hole punched, when the holder came on to the platform. Moreover, there are platform tickets which like the double and the return tickets consist of two parts, one of which is collected on admission to the platform and the other on leaving it.

In France there are, besides Edmonson tickets, also platform tickets printed on paper, 100 being bound together into a book.

The platform season tickets are made of card of larger size; the Italian tickets for a number of admissions are books with a stiff cover and contain a corresponding number of small coupons one of which is collected at each admission.

Question 10. — *Do you print the tickets yourself at your own printing establishment, or do you obtain them from some printing firm?*

In the following countries the railway administrations own printing machines, on which card tickets of the Edmonson pattern can be printed, while the other tickets, particularly the paper tickets, are obtained from some printing firm :

Denmark, England, France, Norway, Austria, Rumania, Sweden, Switzerland, Spain, Argentine Republic, India, Egypt, South Africa.

Germany : Generally speaking only the Edmonson tickets are printed at own printing establishements. Some administrations however also possess machines for printing card tickets of larger size. The other tickets are supplied by printing firms.

Belgium and Hungary : All tickets are printed at own printing establishments.

Bulgaria : The tickets are printed at the State printing establishment.

Italy : The tickets are printed at own printing establishment, except those intended for international traffic and requiring an imprint, which cannot readily be printed by fixed type. The paper tickets are exclusively supplied by printing firms.

Holland : The Edmonson tickets and some of the larger card tickets are printed at own establishment; the others are supplied by printing firms.

Russia : The card tickets are printed at the State printing establishment ; some of the paper tickets are supplied, in accordance with the regulations of the general assembly of the Russian railways, by printing firms.

United States and Mexico : The tickets are obtained from printing firms.

Australia ; The Edmonson tickets are printed partly in own printing establishment and partly in the State printing establishment, while the other tickets are supplied by printing firms.

The machines for manufacturing the Edmonson tickets are mostly supplied by the following firms : Gandenbergersche Maschinenfabrik G. Göbel in Darmstadt, E. Ravasse in Paris, and Waterlow & Sons in London.

Question 11. — *If you have any own ticket printing machines, which can print tickets other than the Edmonson tickets, please send description and illustration of these machines and state what tickets can be printed with them.*

Germany : Some administrations possess so-called two-size machines supplied by

the firm Göbel of Darmstadt, which can be used for card tickets measuring 70 × 46 millimetres (2 3/4 inches × 1 13/16 inches) as well as for Edmonson tickets. The machines are constructed like those used for the Edmonson tickets; when used for tickets of larger size special sliding carriages and funnels are put in instead of the ordinary ones. The Baden State Railway possesses a machine, also supplied by the firm Göbel of Darmstadt, which can produce card tickets of any size up to 135 × 65 millimetres (5 5/16 × 2 9/16 inches).

Belgium : There are machines for printing card tickets measuring 80 × 30 millimetres (3 5/32 × 1 3/16 inches), and so-called *talons valeurs* can be printed. These machines are constructed like those used for printing Edmonson tickets. The machines are supplied by the firm Göbel of Darmstadt.

Holland : With some machines it is possible to print, not only Edmonson tickets, but also tickets measuring 95 × 30·5 millimetres (3 3/4 × 1 7/32 inches). These machines are constructed like those for the Edmonson tickets. The length of the channel through which the tickets pass is such that it can hold either 5 small or 3 large tickets at a time. The larger size is used chiefly for holiday tickets.

Hungary : Besides the Göbel double printing machines with dry stamps used for printing Edmonson tickets, we also possess a Göbel five-colour rotary machine equipped with guilloche roller for tinted impressions, ten sets of six-figure numbering devices, perforating apparatus and cut-off mechanism; this is used for printing mixed tickets for journeys to neighbouring countries.

Question 12. — *Do you use ticket-counting machines, and if so, how are they constructed?*

Ticket-counting machines are not used in Bulgaria, Denmark, Italy, Russia, Sweden, United States and Mexico.

Germany. — *Prussia :* A four-figure counter fixed at the side of the machine forms a reliable control for the correctness of the consecutive numbering. In order to facilitate the control, the machine is fitted with a bell which rings as soon as 100 tickets have run through the machine. The top ticket must bear the same number as that shown by the counter. — *Alsace-Lorraine :* The machines are driven by electric motors. A crank mechanism moves the ticket carriage to and fro. The number of forward movements is recorded by a counter. After every 100 cards a bell is rung.

Saxony : The ticket-counting machines are fitted with a controlling wheel and

a bell mechanism; the latter sounds when 50 and 100 tickets have been counted; at the same time the dry stamp of the administration is pressed in. The counting machines are only used in the case of the tickets printed by means of hand machines. The tickets produced by the electrically-operated printing machines have at the same time the dry stamp of the administration pressed in; but these tickets are not counted over again by means of special ticket-counting machines. The tickets are made up in packets of 100 each; a machine marks on the side of this packet a black diagonal line, from the top left to the bottom right; this at once makes it evident if any tickets have been removed.

Belgium, Norway, Rumania and Switzerland : The counting machines are supplied by the firm Göbel of Darmstadt.

England : Ticket-counting machines are only used by some of the managements. The machines have two perpendicular tubes, one above the other, which are connected by a horizontal slide; there are two wheels with the numbers from 0000 to 9999 engraved; they register how many tickets have passed from the upper to the lower tube (London & North Western Railway).

France. — *State Railway :* The counting machine is driven by an electric motor; it has a six-figure counter which counts two tickets at each revolution; up to 450 tickets can be counted per minute. — *Paris-Lyons-Mediterranean Railway* and *Eastern Railway :* We have counting machines on the Ravasse system. The cards pass through the machine, one after another, so that the printed number on the ticket must agree exactly with the number shown by the counter. Although the machine works very rapidly, counting 4 cards each revolution, yet every discrepancy between the number of the ticket and the counter is at once noticeable, if the counter has been set to the same number as that of the first ticket. The machines are constructed so as to be operated by hand or by motor. When operated by hand, 10,000 tickets can be counted per hour; when operated by motor this number can easily be doubled (this information is taken from a circular issued by the firm E. Ravasse of Paris). — *French Northern Railway :* Counting machines with a drum which counts 4 tickets at each revolution and with a rotary counter are used. — *Orleans Railway :* The chief parts of the counting machine are two holders which are separated by a wheel mechanism with a pawl; the tickets to be counted are placed in the upper holder and drop into the lower holder, acting on the pawl which operates the counter. — *French Southern Railway :* We use counting machines on the Lecocq system. A description of these machines is given in the *Revue générale des chemins de fer* for December 1880.

Holland : The counting apparatus is combined with the ticket printing machine. The tickets are counted before they leave the holder. The construction is generally speaking the same as that of other printing machines.

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Austria-Hungary. — *Austrian State Railway :* The counting machines are so arranged that the printed tickets receive there the deep imprint and are counted by special control counters, which are operated by the tickets as they leave the machine. — *Austrian Southern Railway :* The counting machines consist of an entrance channel, an open passage for the tickets and an exit channel. At the side of the passage a four-figure counter is fixed, which controls the correctness of the succession of the numbers. — *Hungary :* There are five counting machines, four on the Göbel system (Darmstadt) and one on the Kärig system. The counting machines stop automatically each time 50 tickets have been counted.

Spain : Counting machines are available, but they are not used, as they are not practical. The machines only show how many printed tickets there are, but do not indicate any errors in the numbering or the printing. The officials in charge of the printing count the tickets by hand, and go through them a second time before packing them up.

Argentine Republic, India and Australia : Counting machines manufactured by the firm Waterlow & Sons of London are used.

Egypt : Counting machines are used for the Edmonson tickets.

South Africa : Waterlow's improved counting machine is used. The tickets are placed in a tube; a handle is turned by hand and the number is shown on a counter. The tickets when leaving the tube pass over a plate, where the numbers on the ticket can be read and checked.

Question **13.** — *Have you any machines by means of which the ticket clerk can print tickets in individual cases, the tickets being checked at the same time?*

Question **14.** — *If so, please send a description of such machines and inform us what results have been obtained with them. Please send a figure of such a machine?*

Such machines are only in use in Germany, Belgium, France and Holland, and in some cases as an experiment only.

The administration of the Atchison, Topeka and Santa Fe Railway writes :

" Numerous efforts have been made to produce a machine that would print railroad tickets as sold. However, I do not think that any machine has yet been produced that is satisfactory. All machines of this character have as their prime feature the adjustment of a die, the turning of a crank, etc., all of which takes time and delays passenger; in addition to this, the fact that these machines are, as a rule, extremely complicated, and the possibility of their getting out of

order at a critical time, prompts the belief that a satisfactory machine of this character will never be produced."

Germany : On some of the stations of the Prussian-Hessian State Railway there is a machine built by the firm Regina of Kalk near Cologne; the Cologne Directorate reports on 23 December 1907 as follows on the subject :

" The machine supplied by the firm Regina of Kalk for trial has been in use at the chief station here since 1 September 1907. It prints 1,280 different tickets to 324 stations, third class, tickets available for all trains, for express and passenger trains, soldiers' tickets and dog tickets. It occupies comparatively little space, as it is 1·10 metres (3 ft. 7 $^5/_{16}$ in.) long, 0·60 metre (1 ft. 11 $^5/_8$ in.) wide and 1·20 metres (3 ft. 11 $^1/_4$ in.) high. The design is simple, the construction is solid and strong.

" The machine consists of two main parts: *a*) the underframe; *b* the printing machine proper or the printing press.

" The underframe contains the 1,280 printing plates corresponding to the different tickets, in several vertical holders placed next to each other. The stations to which tickets can be printed are given on an alphabetical list fixed to the underframe. The press is then set to the station and class desired by moving forwards, backwards and sideways, an operation easily carried out. The press has a lever mechanism; by turning the cranked handle this mechanism raises the plate required from the holders to the printing table, and after the printing replaces it again in its original position; the printing table is operated by a can which presses the tickets card against the plate. The cards used for the purpose are cut up just like those used in our other ticket printing establishment. Before the printing operation the card must be placed by hand in the opening of the press. No special skill is required for any of these operations. They are easy and do not require any strength. The clerks consequently acquire in a short time so much skill, that the operations are carried out quickly and with certainty.

" Whenever a ticket is printed, then two controlling strips are applied simultaneously and the following information is uniformly printed on: 1° the number of the ticket; 2° the destination station; 3° the kind of train; 4° the class; 5° the fare; 6° the assessment of the duty.

" The clerk has access to the one controlling strip for making up his accounts; the other is under lock and serves as check.

" The machine presents accordingly the following advantages:

" 1° The control can be depended on. The receipts obtained by the sale of the tickets are recorded, simultaneously with the printing, automatically on the controlling strips, one of which, as stated, is inaccessible to the employee. Moreover each time a ticket is printed a counter automatically advances one. This number appears on the ticket as well as on the two controlling strips. At the beginning as well as at the end of the time he is on duty, the clerk has to print a controlling ticket

which he adds to his accounts. These two tickets show how many tickets the clerk has issued.

" 2° The production of two controlling strips gives double safety. It is entirely impossible to sell a ticket out of its proper order. Not only is it a great resulting advantage to the administration, that it is protected against embezzlement and fraudulent book-keeping, but it is also one to the clerks, for the hitherto existing distrust between them is removed. The clerks consequently like to use the machine.

" 3° The strip enables the clerk to finish off his accounts in a very short time.

" 4° The booking-office window can be used continuously, as there are no complicated taking-over operations.

" 5° The accounting is simple. The figures for each day are added up every ten days and submitted together with the first controlling strip. The quarterly accounts merely consist in a summary of the ten-day accounts.

" As opposed to these advantages there are the following disadvantages: as already remarked, the cards must at present be fed into the press by hand. It is true that the cards are stored in a holder in front of the machine, conveniently placed, but this operation nevertheless takes time."

Belgium : The machine described below has been in use a short time, as an experiment; it is not yet possible to give any opinion as to its suitability.

The description is taken from a circular issued by the firm *Appareil Contrôleur*, of Paris (Rue de Chanzy, 44).

Objects of the machine :

To print and issue tickets as required by the passengers, and to check their issue; this is effected simply and quickly by one single manoevre (per ticket issued).

Advantages of the machine :

1° It is no longer necessary to prepare and stock the tickets; ticket cupboards and detail accounting also become unnecessary ;

2° The tickets are issued easily and quickly ;

3° There is an automatic and infallible control which is carried out in the simplest manner simultaneously with the issue of the tickets; it is possible to see at any moment how much cash in hand there should be; errors and embezzlements are impossible.

4° There is a considerable saving because :

a) It is no longer necessary to prepare and stock the tickets and handle them;

b) The controlling and checking is very much simplified.

General description of the machine.

The machine consists of :

1° The case which contains the mechanism, on a stand ;

2° The number of printing stamps on a endless chain for printing the tickets ;
3° A counter which records the amounts received.

Different parts of the machine :

A roll of card, on the upper part of the machine; the end of this roll is fed in to the apparatus. An endless chain with printing stamps is wound off a drum, which is turned from outside by means of a handwheel. Each printing stamp has on it the lettering required for one ticket (date, booking station, destination station, class, kind, fare, special number of ticket). On a list of stations (with the different kinds of tickets for each station : full fare, half fare, soldiers', return) there is a movable index finger, which at the same time moves the printing stamp chain. When the ticket is printed, all the particulars necessary for the control are printed on a controlling strip. A counter (totalizer) shows at any moment how many tickets have been issued by the machine. Another counter records each fare and adds it to the amount already received. All that is necessary is to read this amount off on a disk. Finally there is a special mechanism which enables one, as often as one desires, to record on a statistical strip the number of tickets previously printed by each printing stamp together with the destination station and the fare; this operation takes 3 minutes and corresponds to the complicated accounts the clerk has to draw up when using stocks of ready-printed tickets.

Manipulation of the machine.

Press on the lever to move the drum on which the endless chain carrying the printing stamps runs ; turn the handwheel and thus set the index finger of the station list to the name and kind of ticket wanted. Then the lever is released; the drum is again at rest and the printing stam required is in the correct position. A second lever is pressed down as far as it will go and again released. The ticket desired appears on a tray fixed to the front of the machine. The following operations have taken place simultaneously :

1° All data concerning the ticket have been printed on to the controlling strip ;
2° The special counter (inside the machine) for the printing stamps has avanced one.
3° The totalizer has advanced one;
4° The disk of the counter shows the amount of the fare.

Theoretically a chain can carry any desired number of printing stamps ; practically however the number may scarcely exceed 100 (200 in the case of a double apparatus), for reasons of weight and space. If more than 80 printing stamps are on one chain, an opening must be made in the floor under the stand (20 centimetres [7 $^{7}/_{8}$ inches]) for every 10 printing stamps).

France. — *Paris-Lyons-Mediterranean Railway :* Machines of this kind have been put up at one of our stations, but as yet not enough experience is available. It is the same " *appareil contrôleur* " described above. — *French Northern Railway* : " Appareils contrôleurs " are used, experimentally, at Paris and Enghien.

As regards the machine used on the Paris Metropolitan Railway, for printing and checking tickets, I would refer to the description published in the *Bulletin of the Railway Congress* (1). These machines were also supplied by the firm " Appareil contrôleur " of Paris.

Holland. — *Dutch Railway Company :* We possess " appareils contrôleurs " supplied by the makers in Paris (rue de Chanzy, 44). The machine works well; except that there were some irregularities which were soon remedied.

I have refrained from giving any illustrations of these machines, as they are as yet chiefly used experimentally.

Question 15. — *Have your tickets on them any special mark for protection against fraudulent imitation, and if so what does the mark consist of?*

In the following countries the tickets have no special marks :

England, Egypt, South Africa, Australia.

On the other hand, the dry stamp of the administration is impressed on all tickets in Bulgaria, Norway, Austria-Hungary and Rumania.

In Germany, Denmark, Holland, Sweden and Switzerland most of the administrations impress all tickets, except the Edmonson card tickets, with the dry stamp of the administration.

Belgium : The paper tickets (book tickets), circular-tour tickets, season tickets), are impressed with the dry stamp of the State.

France : The card tickets are often impressed with the dry stamp; also the order number of the destination is frequently printed on. On the French Northern Railway, the tickets other than the Edmonson tickets often have special marks.

Italy : The card tickets have on the front face a fine network printed on, which makes any alteration, such as erasure, etc., impossible. The paper tickets are impressed, before they are sent from the head office to the stations, with the dry stamp of the administration.

Russia : The card tickets are impressed with the dry stamp, and have on them an arabesque network difficult to imitate (Orloff mark) printed in the colour selected

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(1) No. 5, May, 1907, p. 539.

for each class, and with the numbers 1, 2, 3, corresponding to that class. The paper tickets have watermarks.

Spain : Special marks on tickets are only used in special cases, for instance feast trains, pilgrim trains, etc.; they consist of a chain, a dagger, a star, etc. In the case of a joint service the mark " combinado " is used, which is printed in the Morse code on the back of the tickets.

United States of America : The tickets are generally printed on safety paper, which is generally made specially in order to prevent fraud and alteration by acids, etc.; it is supplied by certain paper manufacturers to the ticket-printing firms, who give a written guarantee that they will use this paper for printing railway tickets and for no other purpose. Otherwise part of the paper tickets have no special mark; part of them bear an emblem, the trade-mark of the company, or have as watermark the abbreviated name of the firm or company. On many lines the tickets, also the Edmonson card tickets, have on them the fac-simile of the signature of the general manager of the company.

Argentine Republic : Great Southern Railway. — The tickets are lithographed ; the initials of the company form the protective mark.

Mexico : Safety paper is used for the coupon tickets (see United States of America).

India : The initials of the railway are on the back of the card tickets. In some cases each series of 10,000 tickets is marked A, B, etc.; and in addition the month and the year in which they have been printed is stated. If more than one series is used, each series is designated by a number placed before the letter, *e. g.*, 1 A, 1 B, etc.

CONCLUSIONS.

1° The card ticket known as the Edmonson ticket is still the one most used by all administrations, for single and for return journeys. It is named after Thomas Edmonson, who was born in Lancaster (England) 30 June 1792, and in 1836 became station master on the Newcastle-Carlisle line, where he gradually worked out a machine for printing small card tickets. Later on he became a director of the Manchester and Leeds Railway. As these small card tickets exhibited manifest advantages (*e. g.*, simpler accounting, easier checking, convenient for the passenger) as compared with the written-out paper tickets which were used in the early days of railways, which were generally of the pattern used for posting, they were very soon used not only in England but on the other railways generally.

In the case of longer journeys, particularly if several administrations are concerned, book tickets made up in various combinations, of a uniform pattern, are frequently used. Such book tickets are of very great importance as far as European travel is concerned, for the railways in Germany, Belgium, Bulgaria, Denmark, Finland, France, Italy, Luxemburg, Holland, Norway, Austria-Hungary, Rumania, Sweden, Switzerland, Servia, the Oriental railways and the Warsaw-Vienna Railway, as well as several shipping companies, adopted this system.

Thus there is, very extensively, a standard form of ticket, and in many countries this also extends to the colour of the tickets (for instance in Germany, Belgium, Denmark, France, Austria-Hungary, Norway, Sweden, Switzerland and Spain : first class, yellow; second class, green; third class, brown).

Such a standardization of the ordinary tickets, taking into consideration the fact that traffic is continually extending over longer distances, is very desirable, in the interest of the passengers as well as in that of the railway administrations.

2° There is also in many cases an agreement about tickets as regards regular journeys within given periods of time, inasmuch as season tickets enabling the holder to journey at will on given sections are nearly everywhere issued. The form and shape of these tickets varies (card ticket of larger size than the Edmonson ticket, or in the shape of a book; with many administrations the photograph of the holder has to be stuck on the ticket), but this is not of much importance, as it is generally a question of journeys within the limits of the system of one single administration. In many cases tickets are issued for a given number of journeys on one section; each journey either a hole is punched in at a determined point or else a piece is removed.

3° At the stations everywhere there are kept stocks of ready-printed tickets for all the journeys at all frequently taken; while blank tickets (*i. e.* tickets only partly printed, on which the booking clerk has to enter the name of the destination station, the fare, etc.) are only issued in cases where there is little traffic. As the issue of ready-printed tickets takes a much shorter time than that of blank tickets, the system mentioned provides for the quick booking of the passengers, but on the other hand the necessity of keeping the stations stocked with an excessively large number of different tickets is avoided.

4° The blank tickets should be designed so as to minimize errors in the accounts and frauds as much as possible. This object is attained, by most of the administrations, by retaining at the station a duplicate copy of the ticket delivered to the passenger, which is kept at the station, and then submitted, together with the accounts, to the controlling office. The latter also receives the tickets collected from the passengers in order to compare them with the station accounts. On some railways (particularly in Austria and in North America), the blank ticket has an additional section which is removed by the conductor at the commencement of the journey and is also sent to the controlling office.

5° As regards the manufacture of the tickets, a distinction has to be drawn

between the Edmonson card tickets and the other tickets. In many countries, the former are manufactured by the railway administrations themselves; this is easily and quickly effected by means of well-know machines. The other tickets and passes are generally obtained from private firms, as various types and shapes are in question, and it would be troublesome and expensive for the railway administrations to print them themselves.

6° Quite recently, several administrations also use machines which enable the booking-clerk himself to print the tickets when issuing them, and which at the same time check the tickets printed. If these experiments are successful, there will probably be a revolution in the ticket-issuing system, attended with considerable economy, although it is probable these machines will only be used for the home stations of the administrations, on account of the settlement of accounts with other administrations. This system would save, in the first place, all the wages of the ticket printers, and the complicated and lengthy ticket accounts of the station would be simplified very materially (as an instance, we may mention that at one of the booking offices of the chief station at Stuttgart there are at present 1,736 different kinds of ready-printed tickets and 270 kinds of other tickets). The ticket cupboards which take up much room at large stations would to a great extent become unnecessary. The same booking-office windows, if only used for the sale of tickets which can be printed by the machine, could be used without interruption, as there are no complicated taking-over operations when another clerk comes on duty.

As owing to their high cost, these machines can only come into consideration in the case of stations with much traffic, a necessary requirement is that the printing and issuing of the ticket should be as quick as the issuing of the present ready-printed tickets.

Taking into consideration the importance of the question, I wish to propose that the administrations which own such machines should publish the results obtained, when their experiments have been completed, in the *Bulletin of the International Railway Congress.*

7° In the greater number of countries, special tickets are issued for admission to the station (in many cases only at the larger stations), available either for one admission or for continued admission, at a fixed charge. The ticket entitling to one single admission is, with hardly an exception, shaped as an Edmonson ticket.

SECTIONAL DISCUSSION

Meeting held on 8 July 1910 (afternoon).

MR. DIETLER, IN THE CHAIR.

The President. (In French.) — Mr. von Zluhan will address the meeting.

Mr. von Zluhan, *reporter.* (In German.) — The printed report which you have before you was not drawn up by me, but by Mr. von Stierlin, who has since been carried off by a sudden illness. Mr. von Stierlin has drawn up his report with much zeal and industry; I feel that I must pay him that homage here.

I will in the first place give you a summary of this report, which in fifteen sections investigates :

The nature of the tickets;

The object of the different kinds;

The use of tickets supplied ready printed to the booking office; or

The use of blank tickets to be filled up or altered somewhat by the clerk in charge;

Measures to reduce the number of tickets.

A special paragraph deals with tickets for admission to stations.

Other sections are devoted to the question of the manufacture of tickets and to the machines used for this purpose (ticket-printing machines).

Finally, the report considers the important subject of the precautions necessary to prevent the forging of tickets.

The conclusions of the report are summed up in seven clauses, given on the last three pages of the report.

Now to begin with the question of the nature of the tickets used by the different administrations, I will draw your attention to the collection in eight volumes which are on the table for your inspection. In those eight volumes you will find specimens of the tickets issued by most of the great European railways, by some of the railways in British India, in Africa (Egypt), in Australia, in the United States, in Canada, in Mexico and in the Argentine Republic.

The last volume, the eighth, is a collection of platform tickets.

Thanks to the obliging kindness of many administrations, the reporter succeeded in drawing up a complete account of the different requirements which have to be satisfied and of the means employed to meet those requirements.

That the small Wurtemberg administration comes first, is because its collection is beyond doubt the most complete; hence

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this apparent incorrectness which I hope you will kindly excuse.

As you know, railway tickets had as their prototype stage-coach tickets; the names and destinations of stage-coach travellers were written by hand on paper forms and lists of passengers were written out; in some cases careful identification by means of passports issued by the authorities was insisted on.

This complicated system could not be kept up in presence of the increased traffic.

Another and simpler means had to be found for the hundreds of thousands of people who wanted to travel. This method which is suitable when the number of travellers is great, is the Edmonson system which has as yet not been excelled.

Thomas Edmonson was born 30 June 1792 at Lancaster; after working for some time in a furniture factory, he entered in 1836 the service of the Newcastle-Carlisle Railway which had just been opened, in the capacity of station-master at Milton, a small station on that railway. He was the inventor of the system which bears his name and of the cupboards and dating presses used with these tickets. Thanks to his system, his name is almost as universally known as that of his illustrious compatriot and contemporary, Sir Rowland Hill, the postal reformer.

Passenger tickets have the object, on the one hand, of supplying the railway with a simple and sure means for keeping accounts; on the other hand, of supplying the public with a convenient document showing their right to travel, in all the various cases, and forming a receipt for the fare paid. This double problem was solved in a really ingenious fashion, by the use of a small ticket made of card.

Printed indications and the use of different colours are the chief means by which it is attempted to solve this problem. The simplest is, of course, that all the purposes for which the ticket is to serve should be indicated by a printed text. Thus we find on the tickets of nearly all administrations the information prescribed by the tariffs and the regulations, concerning the departure and arrival stations, the fare, the class. In addition there is often information as to stop-overs at intermediate points, for how long the ticket is available, that the ticket must not be sold or transferred, as to choice of route (railways and waterways), allowance of free luggage if any, customs examination. Besides the fare, some administrations also give the distance from departure to arrival station.

In order to check the time when the ticket has expired, the ticket is stamped, by means of a dating press, with the date of issue, unless that date can be recognized otherwise.

If the international convention for the carriage of passengers, which is now under consideration, comes into force, there will be uniform prescriptions, as regards these indications, on a large number of the European railways.

Book-keeping and accounting are facilitated by the consecutive numbers on the tickets which make it possible, in a very simple way :

1° To check how many tickets the printers have delivered to the booking offices, and consequently the value represented by the tickets the latter have received;

2° To ascertain quickly how many tickets

are left in the ticket cupboards and how many have been issued; also the sums received for the latter;

3° To check subsequently the tickets issued by the booking office and the sums accordingly paid in by the booking clerk.

If it is necessary to supply different booking offices at one station with sets of special tickets, the latter have, besides the checking number, distinctive marks, numbers or letters.

Similarly the tickets issued by agents and by automatic machines have special marks.

Besides the information printed on the tickets, it has been recognized necessary and rational, both in order to accelerate the work of issue and the checking, and to make matters simpler for the public, to differentiate the tickets and the covers of book tickets by using paper of different colours in their manufacture. From this point of view, it is useful to make definite differences between tickets for the different classes, as well as between those available for ordinary and for express trains. The detailed enumeration of all the arrangements adopted would be too long for my summary; the systems adopted by the different administrations vary too much with the tariffs and the services.

With many of the administrations, in Germany for instance, for the book tickets of the international Union and the book tickets known as agents' tickets for journeys in Europe, the colours adopted are as follows :

First class tickets	Yellow.
Second — —	Green.
Third — —	Buff.

In the case of Edmonson tickets for the fourth class, grey paper is used in Germany.

In some cases the colours of the tickets correspond to those of the outside of the passenger carriages.

Tickets available for all trains often have a red line printed across them. Double tickets, formed of two parts, for instance for an outward journey and a return journey, used for successive journeys in carriages of different classes, have the two halves made of different colours.

One also finds tickets of two colours divided diagonally; for instance children's tickets and soldiers' tickets. In addition our collection includes : tickets with two, three or four lines of different colours printed on them, in some cases parallel to the long side, in other parallel to the short side, sometimes on the outer edge (bordered), or in a corner or in the middle of the tickets; tickets with several lines which cross each other, with dots, with large coloured marks or with very visible marks, so that a nearly inexhaustible number of varieties exist.

Shape of the tickets.—As I have already remarked, the most ordinary shape adopted for tickets is the Edmonson shape, with dimensions of 57 × 30·5 millimetres ($2\ ^1/_4 \times 1\ ^3/_{16}$ inches).

Of course those dimensions are not always adhered to; it is often useful, in the interests of the service, to exceed them, for reproducing tariff regulations, for checking purposes and also in the cases of workmen's tickets, season tickets, mileage tickets, tickets for special trains, etc.

Tickets which are available at will over different routes or by different means of carriage have coupons attached which can

be detached by the employees so as to facilitate the accounting work.

Paper tickets. — Tickets which are available over lines belonging to several different administrations are also made of paper, with coupons for the different lines which are going to be used; these are either books with fixed destinations, for use between two definite stations, or else books made up of selected tickets (circular tickets). In this connection, I may mention the organization of international travel, adopted by a certain number of the great railways of Europe (Switzerland, France, Italy, Belgium, Holland, Germany, Denmark, Sweden, Norway, Austria, Hungary and Bulgaria). Books of this kind often contain print in German, in French and in Italian. Tickets with prints in different languages are also found in the internal service of some railways, for instance in Belgium, in India, in Egypt.

Book tickets are also included among the tickets issued by travelling agencies, to whom the railways hand against payment the tickets (paper tickets) they require; the latter then put them together to suit the travellers. As an instance I will quote the Cook's book tickets, which are very generally known.

Among tickets of exceptional shapes which figure in our collection, I may mention : octagonal tickets in France, in South Africa and in Australia (simple and double), oval tickets in France and in Australia.

Besides paper and card, the following materials are also used for tickets : linen for season tickets, and for tickets generally which are going to be used for a more or less considerable period of time; then leather for season tickets in England, in France, in Austria, in Hungary and in Australia.

Trials made quite recently by several directorates of the Prussian State Railway with Edmonson tickets made of thin card, have shown that this is not to be recommended; the saving of about 1·6 per cent in the cost of the card is counterbalanced by the greater cost of printing on the existing machines.

In Australia season tickets consist of metal disks (silver or gold) of oval or circular shape, which can be hung from a watch-chain. The section for which the ticket is available is indicated by letters or numbers.

Classified by class of train and of carriage, there are tickets for ordinary trains, express trains, "*trains de luxe*", special trains of all kinds, tickets for Pullman cars in the United States, sleeping-car tickets, sleeping-berth tickets, reserved-seat tickets.

In order not to overload the stations with excessive supplies of tickets, supplementary tickets (zone tickets) are issued, which taken together with tickets for ordinary trains entitle the travellers to go by express trains or by a higher class. There are excess tickets for the additional charges which have to be paid by passengers having tickets which do not go far enough, or which are for classes and trains for which the tickets are not available, or by passengers who have no tickets.

Our collection altogether contains three chief kinds of tickets :

1° Tickets for a journey over a given route (single tickets, return tickets, simple circular tickets);

2° Tickets available for several journeys over a given route, namely :

a) For a given number of journeys, books with detachable coupons for ten, twenty, thirty or more journeys, or cards with dates printed along the border, the date being marked by punching or otherwise when a journey is taken ; workmen's tickets (week tickets) which can utilized twice a day or twice a week ; pupil tickets available on certain week days or by certain trains ;

b) For travelling at will on a given section during a given time ; season tickets for a week, a fortnight, a month, a quarter, a year. Among these we can also class the season tickets known as general, for travelling on all the lines of a whole railway system for a given length of time, in Switzerland, in Denmark ;

3° Mileage tickets, on a differential basis, used especially in Switzerland, in the United States, in South Africa and in Russia, usually at a reduced rate ; they can sometimes be utilized by the members of a firm or of a family, during a given period of time. As a general rule, they are used for exchanging at the booking office for a ticket for a single journey, of so many miles, to a given point on the line.

In order to promote sport, health and especially also excursions for the populations of large towns, there are issued : tourist tickets, Sunday tickets, bicyclists' tickets ; holiday, summer, season tickets ; tickets to watering places ; school excursion tickets and family excursion tickets ; week-end tickets for going out of town and returning, stopping over Sundays and also feast days, tickets for going to horse races.

Special tickets, as a rule at reduced fares, are issued : to passengers who are not adults (children from 4 to 10 or from 10 to 12 years of age), for pupils, for workmen, for members of the armed forces (lower grades of the army and navy), then for commercial travellers, for engineers, for emigrants, for pilgrims (Switzerland, India), then, in India, for servants.

I, finally, have to mention the tickets for charitable purposes generally (care of the sick). Nor let us forget the tickets for man's faithful companion, namely dog tickets.

As I have already stated, it is impossible to enter into the details of the various peculiarities of the tariffs and regulations which have to be considered in connection with the different kinds of tickets.

I must content myself with having given you a summary account of the varied conditions which have to be considered in connection with passenger traffic and the tariff policy of railways.

Blank tickets. — Seeing the great number of relations between stations (for instance Anhalt Station at Berlin has 47,000 different tickets) and the many needs of the traffic, it is not possible to supply booking offices with ready-printed tickets for all the stations of a railway or of an association of railways and for all cases which may arise. It is hence indispensable to limit the number of the tickets. Among such measures we may mention the use of blank tickets for several passengers (tickets for societies, to be filled up by hand), then the issue of collective tickets, having printed on them the name of several stations for any one of which the ticket is available. These tickets assume that the fare is the same for all the distances or stations considered. Smaller

differences of distance between stations can be neglected.

An effective means for reducing the number of tickets and supplies necessary at stations, a means adopted by most of the administrations, consists in the use of blank tickets. In this case, part of the indications which are printed on the ordinary definite destination tickets are entered by hand or by some mechanical method, by the booking clerk in each individual case. They are more especially: in cases of little traffic between two stations, where it does not seem necessary to provide a stock of completely-printed tickets; in case of unforeseen exhaustion of the stock of definite-destination tickets; for excess charges, for instance in cases of involuntary or intentional change of class, or of continuation of the journey beyond the point the ticket is available to. Some administrations use blank tickets of a shape and appearance similar to that of ordinary Edmonson tickets. Other administrations use blocks of blank tickets made of paper. As a rule, blank tickets are less satisfactory than definite-destination tickets from the point of view of book-keeping and of checking the accounts. It is a little more difficult to check the tickets on the trains and at the platform entrances; the employees can more easily go in for frauds. Various measures have been taken to obviate these disadvantages. In the first place endeavours are made to reduce to a minimum the particulars which have to be filled in or added, especially as concerns the fares. Those parts of the blank tickets on which the entries have to be made are sometimes arranged so that any ultimate alterations by erasure, etc., becomes impossible. Moreover, the tickets bear printed consecutive numbers for checking purposes.

The blank tickets are issued at the station from duplicate books, the original being kept at the station for checking purposes; or else the blank ticket has a section which has to be filled in like the ticket delivered to the passenger.

In writing on the blank tickets, it is advisable to use hard pencils, so that the writing may be legible. The counterfoil and the ticket must have the date stamp impressed on them.

In some countries, in Italy for instance I think, an ingenious attempt has been made to check the blank tickets to some extent by forming them of two coupons which have the price printed on (in francs). At the time of issue, the employee cuts the ticket so that the coupon remaining at the stations for book-keeping purposes indicates, in francs, the same sum as the coupon given to the passenger.

In Rumania, the blank tickets consist of two Edmonson tickets joined together, showing the name of the issuing station and also the price of the ticket in francs (from 1 to 60 francs [10*d.* to £2.8*s.*]). The booking clerk has only to enter the class, the destination stations and the centimes. One of the tickets is detached by the booking clerk and serves as check.

On certain of the lines in India there are blank tickets, with indication of price, for different distances (up to 100, up to 250, up to and beyond 500 miles).

As against the disadvantages inherent in blank tickets, one must mention as advantages, firstly, the already-mentioned possibility of reducing the number of ready-printed tickets, the possibility of using one and the same ticket for several

passengers, finally, and above all, the advantage of the through booking of passengers and luggage to all stations to which definite fares either exist or can be worked out by the clerk. The rules adopted by the the different administrations as to the importance of the traffic for which ready-printed tickets are issued, even as regards the case of an association, differ widely, as you will see from the report you have before you : it varies between 4 and 600 tickets per year.

Platform tickets. — The question of the need of special tickets for admission into the stations, when it is not a question of tickets proper, has received a different solution according to whether the administration closed the stations completely or partially. The system of closed stations can in the first place recommend itself owing to general reasons, firstly, in order to make the platform accessible to passengers and secondly in order to remove other people, in the interests of the service. The platform must not form a promenade for the public. The need of such a measure is especially apparent in the case of stations in towns and in that of busy stations generally. On the other hand, the institution of special tickets for admission to the platforms becomes necessary when the tickets are checked not on the train itself, but at the entrance of the departure station and at the exit of the arrival station. In this case the tickets of the passengers who go on to or leave the platforms must be carefully checked.

According to the report we have before us, the complete closing of the station only exists, and special tickets for admission to the platforms, as a general rule, are only required in Germany, in Belgium, in Bulgaria, in Italy, in Austria, in Hungary, and in Egypt, A mixed system, including special tickets only for admission to stations of a certain importance, has been adopted in Denmark, England, France, Holland, Norway, Rumania and Sweden, as well as by the Indian and Australian railways, and in very rare cases, by railways in the United States. The other countries, especially Switzerland, do not have platform tickets or only issue them to hotel servants.

In the collection of tickets submitted to your examination, a special volume contains specimens of the platform tickets issued by a certain number of administrations. Nearly all the administrations which have adopted the system of platform tickets issue tickets giving right to one single admission. These tickets are usually of the Edmonson type; there seems to be a predilection for selecting conspicuous colours and marks, easy to distinguish from those of the ordinary tickets. Some administrations limit the time of validity of the tickets to a certain number of hours (from one to two hours). These administrations use tickets on which the number of hours for which they are valid are printed, and the tickets are punched when entering and when leaving. Sometimes the platform tickets bear the inscription : " Not available for admission to carriages. " Some administrations, Denmark, for instance, use a system of double tickets, analogous to return tickets.

The cost of a ticket entitling the holder to *one single* admission generally varies between 5 and 25 centimes (between $^1/_2$ *d.* and 2 $^1/_2$ *d.*). The issue of these tickets by means of automatic machines seems a rational proceeding.

The collection of specimens, which is before us, shows that the administrations of the railways in Denmark, Holland, Italy, Austria, Hungary, Norway, Spain, British India and Australia issue tickets for a number of admissions : monthly tickets, quarterly tickets, half-yearly tickets, yearly tickets. Such tickets are not generally of the Edmonson type, but in book form or other special form. Their cost varies considerably. In Italy a scale of rates has been made according to station, whether first or second class, for 20, 40 or 80 admissions; these tickets have small coupons, one of which is detached at every admission.

The question of granting free access to certain persons, not holding platform tickets, to the reserved parts of the stations, for reasons of public or of business interest, has been solved in different ways on different railways. While some administrations only allow admission generally to the holders of tickets they have paid for, others make exceptions for reasons of a public kind, for instance in favour of legal and court officials, of police and of sanitary officials, of delegates of the committee for preventing the white-slave traffic, etc.

Certain administrations, for instance most of the German railways, refuse in principle to treat hotel servants on another basis than the general public; other administrations on the contrary grant free admission to these servants.

Manufacture of the tickets. — The methods of manufacturing the tickets vary with the different administrations; some think it advisable to have their own printing establishments, others do not. Most of the administrations manufacture at least the greater part of their tickets, the Edmonson tickets, in their own printing establishments and only obtain from private firms the paper tickets (book tickets for definite journeys and leaves for making up into books), the strip tickets and the season tickets. Few administrations print paper tickets themselves. The railways in the United States and in Mexico as a rule order their tickets from printing firms.

The printing machines used as supplied more especially by the firms Ravasse, of Paris; Waterlow & Sons, of London; and *Gandenbergersche Maschinenfabrik Georg Göbel,* of Darmstadt. Some of these machines can also be used for printing tickets of a size larger than that of Edmonson tickets, for instance 70 × 46 and 135 × 65 millimetres ($2\ ^3/_4 \times 1\ ^{13}/_{16}$ and $5\ ^5/_{16} \times 2\ ^9/_{16}$ inches).

I may be allowed to refrain from giving details of these machines. I will limit myself to mentioning the following points: most of the administrations use printing machines with electric motor. Often automatic counters are added to them. Some administrations have special counting machines. Other do not use these, particularly in the case of printing machines with electric motor; they are satisfied with the accuracy of the latter.

The tickets are generally put together in packets of one hundred tickets. Sometimes the packets have on the side a black line or mark which makes it possible to see at once if a ticket has been taken out of the packet. For some time trials have been made to count the tickets and put them together in packets automatically.

At the stations the tickets are got ready for issue by placing them in special cup-

boards, arranged in two ways; sometimes they are placed one on the other so that the lowest number is at the bottom; sometimes they are placed upright, with the lowest number in front. A system has now been in use for some time in which the tickets are printed on strips which are rolled up. The different tickets are separated by perforations and hence can be easily detached. The object of this system is to prevent intermediate tickets from being fraudulently removed. A ticket cupboard of this kind is exhibited, if I am not mistaken, in the German railway section at the Brussels exhibition, by the Berlin Company *Deutsches Post- und Eisenbahnverkehrswesen*. According to a note recently published in the *Zeitung des Vereins*, the Austrian State Railway has also lately undertaken trials with tickets in rolls.

Automatic ticket machines. — The tendency, in all branches of work, of replacing human labour by mechanism has led in recent years to the construction of ingenious machines for the sale of tickets. I speak of the automatic ticket-supplying machines, available for the use of the public. Originally designed to meet very simple conditions, they have recently been considerably improved. They are more especially useful in the case of services between adjoining stations, and in that of suburban services.

Machines for printing tickets as and when required. — On page 20 of the printed report (1) you will find the results of the inquiries into the use of machines by means of which tickets are printed by the booking clerk and checked, as and when required. It is unnecessary for me to urge the great utility of these machines, provided they are suitably designed and work so as to safeguard the pecuniary interests of the administrations. The stock of tickets in the booking office can be materially reduced, and accounting and checking operations can be much simplified if the machines are equipped with self-contained checking apparatus. At the time the printed report was drawn up, machines of this kind were in use only in Belgium, in France, in Holland and in Germany. I do not know with certainty whether matters are changed now; but I think I may assume this to be the case. At least I have been told that the English machine, used by German railway administrations, has been ordered extensively. The Belgian State Railway has kindly informed me recently that its " *appareil contrôleur* " (Paris, rue Chanzy) has not yet given results sufficiently definite to enable the administration to decide to adopt it in practice; that the printing press proper works well enough, but that the counters leave something to be desired, probably because the actual operation, being by hand, is a little uncertain; that electric motors are going to be fitted and that new trials are going to be made.

The administration of the French Northern Railway has been good enough to write to me, annexing a number of the *Revue générale des chemins de fer* for 1904, that the " *appareil contrôleur* " has been recently improved and that it intends to make trials with a new apparatus exhibited at Brussels, with an automatic counter. The Paris-Lyons-Mediterranean Railway is satisfied with this machine.

(1) See also *Bulletin of the Railway Congress*, December 1909, p. 1786.

In Germany, according to my inquiries, such good results have been obtained with the printing machine suppied by the firm Felten & Guillaume Lahmeyer of Francfort on the Maine, in use at Cologne and also at Essen, Mayence and Strasburg, that the administration of the Prussian State Railway is, it seems, considering the advisability of using it on a large scale. I have asked that one of these machines should be sent here so that I might show it to you. The manufacturer has also placed at my disposal a number of prospectuses, etc., which I have placed on the table.

Just as in the case of the automatic distributing machines, I do not propose to give a long description of this ingenious and complicated machine. I will merely mention that with a machine of this kind it is possible to print up to 2,000 different tickets, and even more, at the time they are issued, by simple operation of a lever, without delaying the passenger, even if the work is carried out by women; and that the tickets are at the same time recorded on two check slips, one for the use of the clerk when making up his accounts, while the other, which the clerk cannot get at, is intended for checking purposes. Besides the firm mentioned above, it seems that the *Gandenbergersche Maschinenfabrik G. Göbel*, of Darmstadt, is also engaged in constructing machines of this kind. This firm has also sent us a certain number of illustrations and descriptions of their machines for producing tickets.

Precautions against forgery. — Owing to the occasionally high price of tickets, there is naturally a temptation to put into circulation, to the detriment of the administration, forged tickets, with or without the connivance of the railway employees.

It hence seems advisable to have special marks on the tickets as a protection against forgery. With this object in view, some of the administrations impress their tickets with a dry stamp, either both the card and the paper tickets, or at least the paper tickets (books for definite journeys or made-up books). In France, as an extra safeguard, the tickets have printed on them the number of the station. In Italy and Russia a fine network is printed on the face of the tickets, so as to prevent any erasures and alterations. In Russia a special network is used. Several railways in the United States and in Mexico use paper specially made for the purpose. Other precautions consist in having on the tickets the trade-mark of the company or the initials of the company or the facsimile of the signature of the general manager of the company. Some administrations, for instance those in Great Britain, in Australia, in Egypt and in South Africa, use no special marks.

Free passes. — Gentlemen, I should be guilty of ingratitude if, to finish up with, I said nothing about a variety of tickets particularly dear to many of us and fully appreciated : I mean the free passes which have enabled us to come here and meet for our joint labours. I have made no special study of this subject, nor have I made a collection of specimens. You all know the subject from your own personal experience. You also fully appreciate the international exchange of these free passes by which our employees largely benefit during their leave, and in case of illness and other cases.

These passes are generally of paper or of parchment. There are also, for in-

stance in England, metal passes of very solid make and rather heavy. But those entitled to use them carry them certainly quite as readily as our lighter passes. No doubt, in our organization there is lacking one thing which makes it less complete than the free passes (*tractoria*) of the Roman and Frankish posts which granted, in addition to free conveyance, hospitable cheer at the stopping places, in accordance with the rank of the traveller, and that on a very liberal scale. We can hardly develop our free-pass system to this extent and I accordingly think I can end, without proposing any conclusions on this point, by expressing our best thanks to the hospitable Swiss administrations for the amiable way in which they have received us and our companions, and for the liberality with which they have given us free conveyance on all the lines in beautiful Switzerland.

As I have already stated, the conclusions relating to the subject which we are considering are given on the last three pages of the report. I will yet draw attention to the following points :

1° Up till now, the Edmonson ticket is the one most used. However, is seems advisable to try to modify this system so that the tickets can be detached from rolls placed in special apparatus.

With this method of dividing up the tickets, the checking would clearly be much facilitated ; it is less easy fraudulently to remove intermediate tickets.

When conditions are a little more complicated, it is indispensable to use paper tickets also ;

2° Blank tickets form an effective means of reducing the excessive number of tickets. In order to satisfy requirements, it must be easy to fill them in, they must be legible, and the means of checking them must be such as to prevent fraud ;

3° The use of mechanical apparatus, in order to relieve ticket-printing establishments and clerks at booking offices, should be extended as much as possible. More especially should great attention be given to the use of ticket-printing machines at the booking offices of large stations. The results of such experiments made by the administrations should be published in the *Bulletin of the Congress*. (*Applause.*)

The President. (In French.) — I shall no doubt express the opinion of the whole meeting by thanking Mr. von Zluhan for the excellent summary he has just given us. (*Applause.*)

Mr. Minet, Belgian State Railway. (In French.) — The regulations state that any one speaker should not speak for more than half an hour. Now the reporter has spoken for nearly an hour, while presenting the summary of his report, which seems to contain new information which is not found in the printed report which we have before us.

Mr. von Zluhan. (In German.) — I have read my summary very slowly so as to make myself more intelligible to those who do not understand German well. Moreover, I have had to allow for the fact that the report was printed more than a year ago. In the meantime, new experiments have been made with printing machines ; it was accordingly necessary to deal with this point more in detail and mention the new inventions.

Mr. Brandt, Dutch State Railway. (In French.) — The difference between Mr. von

Zluhan's conclusions and those of Mr. von Stierlin relate chiefly to the use of printing machines at the booking offices of large stations. Numerous experiments have been made during the last few months, in France and in Belgium, with a machine for printing the tickets.

The President. (In French.) — The Regina ticket-printing machine, made by the firm Felten & Guillaume Lahmeyer, of Francfort on the Maine, has just arrived. I invite the members of the 3rd section to go into the adjoining room in order to examine this machine.

— The meeting adjourned 3.18 p. m. and met again at 3.55 p. m.

The President. (In German.) — We resume the discussion of question XI.

I call upon Mr. Domsch.

Mr. Domsch, Saxon State Railway. (In German.) — Among the explanations given by the reporter, no doubt the greatest interest centered in those about the ticket-printing machine, the Regina machine shown to us. In fact this is an apparatus which can, in suitable cases, lead us to transform to a certain extent the ticket service. From this point of view, great importance must be attached to the fact that the new German machines make it possible to use a large number of different printing stamps, whereas with the old "*appareil contrôleur*" this number was limited to one hundred. The essential difference is that with the "*appareil contrôleur*", at least with the type which I know, all the printing stamps have to be shifted, together with the chain carrying them. The work the clerk has to do accordingly becomes more onerous as the printing-stamp chain becomes heavier. With the Regina machine, supplied by the firms Felten & Guillaume Lahmeyer, on the contrary, each printing plate comes out of the holders and is raised to the printing table; and after the printing the plate is replaced in its original positions. Hence, it follows that a much larger number of plates can be used with the Regina machine. As we have already been told, up to 2,000 plates can be used with it.

The reporter has already mentioned the great advantages of the ticket-printing machine from the point of view of the saving in printing, the stock of tickets, the book-keeping and even the booking-office service, under varying conditions; it is true that up till now it is only a question of experiments and that as yet no definite opinion can be given of this machine. But it already seems certain to me that the ticket-printing machines can only be used at stations where there are several booking offices; at a station with one single machine, this might break down and one no longer would be able to use a neighbouring machine.

What I have just said shows that it would be wrong to try to improve the ticket service only by trying to find a good ticket-printing machine. It should also be tried to make innovations tending to simplifications and economies in making, storing and issuing tickets. A well-organized railway administration is bound to pay every attention to this department, however secondary it may seem as compared with others. Accordingly the administration to which I belong, and other German administrations also, some time ago began numerous experiments

which it perhaps would be advisable to enumerate here, although the reporter has already said a word about them.

These experiments relate to the following points :

1° *The use of a cheaper card for the Edmonson tichets.* — Now that return tickets are nearly wholly abolished in Germany and that the validity of single tickets is four days, the tickets remain such a short time in the hands of the passengers that one can use card which is, if not thinner, at least of poorer quality and consequently cheaper than that at present used by many of the administrations. But the quality of the card must not be so poor that the ticket-printing presses are affected. At present my administration feels convinced that this modification will in the long run enable it to effect appreciable economies.

2° *The use of thinner card, particularly in the case of local and suburban traffic.* — For the local and suburban traffic, where the tickets do not remain tn the possession of the passenger for more than an hour or two, thin and flexible card may sometimes be used, which is still cheaper than that just mentioned. It must however not be too thin to receive the imprint of the date, whether by the dating machine or by the hand stamp of the clerk.

This experiment is at present being carried on and my administration can as yet give no opinion about the results.

3° *Tickets in rolls.* — The use of thin card makes it possible to print the tickets and store them in rolls, without cutting them apart beforehand ; perforation makes it easy to detach the different tickets. These ticket rolls seem especially useful for use in automatic ticket-issuing machines. One is also engaged in making cupboards for ticket rolls so that each division can hold a roll of several hundred tickets and from which the clerk obtains the ticket by tearing it along the line of perforation. Experience will show whether this innovation, which is intended to prevent the removal of intermediate tickets, is advantageous and whether it will frequently give trouble. One trial has already shown that the roll easily becomes entangled. But it seems that the holders have been improved since.

4° *Tickets in blocks.* — One can also, by using card which is somewhat thin, put the tickets together in blocks of fifty, and place these blocks side by side in a cupboard designed for the purpose. This system is also under trial at present; it is thought to be convenient for small stations and for the issue of tickets by the train conductor.

5° *Automatic machines for delivering ordinary and platform tickets.* — Numerous trials have been made of new types of automatic machines for delivering ordinary and platform tickets, and some of them have already given very satisfactory results. The old machines, with which the passenger had to insert a coin, then operate a lever, etc., in order to receive a ticket which had been cut off and printed in advance, no longer suffice for the needs of large stations and one begins to give them up. The new machines have clockwork or electric gear, print the tickets, separate them from the roll and deliver them to the passenger; all the latter has to do is to introduce the coin prescribed. Such machines can also be constructed so as to work when several coins are introduced, or to give change for a coin of

higher value. Hence, they form, not only for platform tickets but also for tickets for the local and suburban services, a valuable addition to the booking-office service. The high initial outlay they represent can often be completely redeemed by the saving in the cost of printing, etc., and by the work saved the booking office clerks.

Unfortunately it is as yet hardly possible to draw any definite conclusion from any of the experiments mentioned, which are in progress, mentioned under 3°, 4° and 5° above; nor can this be done as regards the Regina machine and the patents of the German firms. It is probable that many other administrations outside Germany are making similar trials.

It would hence be a matter for congratulation if the Congress continued to devote its attention to this question and would act as intermediary for the exchange of the results obtained by the different administrations. But I will go further in this direction than the reporter, and I will propose that this exchange of information should not be limited to publication in the *Bulletin*, which would perhaps not take place till after repeated request; I would propose that we at once consider the advisability of placing the question of the improvement and the simplification of the ticket service, in the agenda of the next session of the Congress.

The President. (In German.) — Does anybody else wish to address the meeting?

The bureau only has eight copies in French and in German of Mr. von Zluhan's conclusions. Accordingly it is impossible to give one to each delegate and under these conditions it would no doubt be preferable to adjourn the discussion to tomorrow morning. At that time a sufficient number of copies of the conclusions will have been printed. I would also remark that Mr. von Zluhan's conclusions are much more concise than those printed in the report. They consist of three paragraphs and it will not take long to discuss them.

You will also have to decide about the proposal last made and to say whether you will expand one of the three clauses for this purpose or will add a new one.

Mr. de Tchérémissinoff, Permanent Commission of the Congress. (In French.) — If the President would read out the conclusions we could already begin the discussion and continue and finish it tomorrow.

The President. (In German.) — This is Mr. von Zluhan's first conclusion : " The ticket is the Edmonson type and is at present the one most used. We ought to attempt to divide the tickets in special apparatus. Moreover, the system of made-up tickets can be used."

Mr. Tondelier, *vice-president*. (In French.) — I do not quite understand the meaning of the second sentence : " We ought to attempt to divide the tickets in special apparatus."

The translation perhaps does not give the exact German meaning.

Mr. von Zluhan. (In German.) — With the new apparatus which makes it possible to detach from the roll a ticket having the same size as the Edmonson ticket, the strips of card are perforated. With the system of tickets in packets, an intermediate ticket can be removed, while this is

not possible in the case of a roll. It is advisable to make trials as to the working of these apparatus. The manufacturers mention as the chief advantage of these apparatus that the rolls prevent any swindling in the booking office.

Mr. Tondelier. (In French.) — Is the reporter wholly considering tickets made in special apparatus? Does he ask that one should try apparatus for dividing the rolled strips of paper, then to be printed on, in special machines?

Mr. von Zluhan. (In German.) — There are two classes of tickets on rolls : 1° the tickets printed by the printer which the clerk places in his cupboard ; 2° the tickets printed by a special machine. This is the automatic apparatus mentioned by Mr. Domsch from which the public or the clerk can obtain printed tickets in exchange for a coin which is introduced.

The President. (In German.) — Then we are to retain the sentence concerning attempts, so that the conclusions may cover both systems?

Mr. Domsch. (In German.) — Would it not be better to say : " It is advisable that we should make experiments with a view to improving the present form of tickets, by using, for instance, strip tickets or ticket rolls."

Mr. von Zluhan. (In German.) — I agree.

The President. (In German.) — It is a question of knowing whether we agree in principle to express the wish proposed. If so, we will draft a conclusion which we will submit to the section tomorrow morning.

Mr. Tondelier. (In French.) — The report does not mention the disadvantages of the Edmonson system. Nor does it speak of the need of improving it.

The President. (In French.) — This is the whole question. Must we look for another system?

Mr. Kareiska, *principal secretary.* (In French.) — What is the reason why the reporter wants trials made?

When the tickets are placed one on the other, they can be separated by an intermediate piece of paper.

Mr. von Zluhan. (In German.) — Gentlemen, since the printed report was issued, new inventions, I again remark, have been made, among others that of machines printing the tickets on rolls. I also stated that these machines were exhibited at Brussels. The manufacturers of the machines explain that any fraud on the part of the employees becomes impossible, the checking of the tickets being automatic. It is just the absence of this checking which is the great disadvantage of the system of having the tickets in packets. In drawing up the conclusions, I started from the point of view that it appeared advisable to make trials and collect information about the services the new systems can render.

The President. (In German.) — It is asked whether we are to add this sentence or not. I think that these trials will be carried out even if the Congress does not expressly request this. If we have any doubts as to the need of this sentence, it would perhaps be better to omit it. After all, we must only submit conclusions

which we have investigated completely and all agreed to.

Mr. Tondelier. (In French.)—We should limit ourselves to the statement that we have taken note, with much interest, of Mr. von Stierlin's report and that we express the desire that the question should be among the agenda for the next session of the Congress; the different administrations will give information about the trials which they have made with a view to improving the system of passenger tickets.

The President. (In German.) — I think with Mr. Tondelier that we may limit ourselves to thanking the reporter and to stating that the section thinks that there are still further improvements which it is possible to introduce. We would add that the administrations should continue to investigate the subject which should be placed on the agenda of the next session.

That conclusion would satisfy Mr. Domsch, and at the same time would eliminate all details, about which we find it difficult to come to a conclusion.

Mr. de Tchérémissinoff. (In French.) — The reporter has stated today that improvements have been introduced since the printing of the report.

Now these improvements are so recent that it would be preferable to wait some time for their results.

The President. (In German.) — If the meeting agrees with Mr. Tondelier, the bureau will draft a text for tomorrow morning. (*Approval.*)

Meeting held on 9 July 1910 (morning).

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The President. (In German.) — The bureau has drafted a new text concerning passenger tickets. At the request of the reporter, we have retained clauses 2° and 3°.

This is clause 1° of the conclusions :

" The Edmonson ticket is at present the one most used. Recently machines have been constructed in which these tickets can be separated from a card roll. In special cases, however, paper tickets can not be dispensed with."

In drafting these conclusions, we have tried to co-ordinate the different proposals which were made yesterday. The conclusions have consequently become somewhat longer.

— Adopted.

The President. (In German.) — Clause 2°, runs as follows :

" Blank tickets suitably correspond to the need of limiting the excessive number of tickets. But in order to attain their object, it must be possible to make them easily and legibly, and there must be means of checking to prevent fraud."

Mr. Tondelier. (In French.) — In order to be quite clear, we should replace the words " correspond to " by the word

" satisfy ". We would then say : " Blank tickets suitably satisfy, etc."

Mr. Minet. (In French.) — What we are aiming at, is reducing the number of tickets placed in the ticket cupboards at the disposal of the clerks. I therefore propose to say :

" The use of blank tickets is justified by the need of reducing as far as possible the number of tickets in the ticket cupboards. But in order to be suitable, they must be easily filled in and be legible ; and it must be possible to check them so as to prevent fraud."

— Clause 2° thus amended is adopted.

The President. (In German.) — Clause 3° runs as follows :

" In order to relieve ticket-printing establishments and the clerks at booking offices, it is advisable to extend, as far as possible, the use of mechanical apparatus ; attention should be paid especially to the use of printing machines at the booking-office windows of large stations. The results of the experiments made by the administrations for the purpose should be communicated by means of the Congress publications."

Mr. Minet. (In French.) — I propose that the last sentence should be replaced by this wording :

" The results of such experiments made by the administrations should be published in the *Bulletin of the Congress*."

— Adopted.

The President. (In German.) — Clause 4°, which will give satisfaction to Messrs. Domsch and Tondelier, runs as follows :

" Taking into consideration the improvements and simplifications introduced since the printing of the report, in the manufacture and in the issue of tickets, and those which may be still further realized in the future, it is desirable that this subject should again be discussed at the next meeting of the Congress."

— Adopted.

The President. (In French.) — We have accordingly finished the investigation of question XI and we will submit to the general meeting the conclusions we have just adopted.

DISCUSSION AT THE GENERAL MEETING

Meeting held on 14 July 1910 (morning).

MR. P. WEISSENBACH, PRESIDENT, IN THE CHAIR.
GENERAL SECRETARY : MR. L. WEISSENBRUCH.
FIRST ASSISTANT GENERAL SECRETARY : MR. MÜRSET.
SECOND ASSISTANT GENERAL SECRETARY : DR. A. BONZON.

Mr. Kareischa, *principal secretary of the 3rd section*, read the

Report of the 3rd section.

(See *Journal quotidien de la session*, No. 7, p. 9.)

" In place of the late Mr. von Stierlin, the author of the report, Mr. VON ZLUHAN (*Wurtemberg State Railway*), gave a summary of the different systems of passenger tickets adopted by fifty-seven railway administrations in different countries. The tickets were made of card, paper, leather or metal, and were very frequently of the Edmonson pattern, or were made up into books, or other forms, in accordance with the different conditions in the tariffs. A distinction was drawn between completely-printed tickets, and blank tickets. In certain countries, it was necessary to have tickets for admission to stations; in other countries, this only applied to very large stations; finally some administrations required no tickets for admission to stations. The administrations as a rule printed the Edmonson tickets themselves, while the other tickets were obtained from private printing works. Many countries had machines for counting the tickets. At some of the large stations in Germany, in Belgium, in France and in Holland, the tickets were printed in the booking offices as and when required. In order to prevent forgery, the tickets were impressed with a dry stamp, or had network on them, or some other special marks. Mr. von Zluhan then read his conclusions, which were not quite the same as those in the report.

" The delegates then examined a Regina ticket-printing machine, manufactured by Messrs. Felten and Guillaume Lahmeyer, of Frankfort on the Maine, which was exhibited.

" Mr. DOMSCH (*Saxon State Railway*) ex-

plained the advantages of this machine; he observed however that in practice it was not suitable except for large stations. He recommended the continuation of trials of Edmonson tickets made of cheaper or of thinner card, as well as of tickets in rolls, of tickets in blocks and of automatic ticket-distributing machines. It would be desirable for the Congress to retain the question on the agenda for the next session.

" After sundry observations by Messrs. TONDELIER and MINET (*Belgian State Railway*), DOMSCH, KAREISCHA (*Russian government*), VON ZLUHAN and DE TCHÉRÉMISSINOFF (*Permanent Commission of the Congress*), the following conclusions were adopted."

The President. (In French.) — The following are the

CONCLUSIONS.

" 1° The Edmonson ticket is at present " the one most used. Recently machines " have been constructed in which these " tickets can be separated from a card roll. " In special cases however, paper tickets " cannot be dispensed with.

" 2° The use of blank tickets is justified " by the need of reducing as far as possible " the number of tickets in the ticket cupboards. But in order to be suitable, " they must be easily filled in and be " legible; and it must be possible to check " them so as to prevent fraud.

" 3° In order to relieve ticket-printing " establishments and the clerks at booking " offices, it is advisable to extend, as far as " possible, the use of mechanical apparatus; attention should be paid especially " to the use of printing machines at the " booking-office windows of large stations. " The results of such experiments made by " the administrations should be published " in the *Bulletin of the Congress*.

" 4° Taking into consideration the " improvements and simplifications introduced since the printing of the report, " in the manufacture and in the issue of " tickets, and those which may be still " further realized in the future, it is desirable that this subject should again be " discussed at the next meeting of the " Congress."

— These conclusions were confirmed by the general meeting.

SECTION III : WORKING

[621 .132.8 & 621 .33] QUESTION XII

MOTOR VEHICLES

(2nd, 3rd and 5th SECTIONS MEETING JOINTLY)

The use and cost of motor vehicles or self-moving cars.

Reporters :

Great Britain. — Mr. T. Hurry Riches, locomotive, carriage and wagon superintendent, Taff Vale Railway.

America. — Mr. C. Peter Clark, second vice-president and general manager, Buffalo & Susquehanna Railroad.

Other countries. — Mr. L. Greppi, divisional superintendent (central department for rolling stock and locomotives) of the Italian State Railway.

QUESTION XII

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N. B. — Vide also the separate issues (in red cover) Nos. 11, 36 and 40.

[621 .132.8 & 621 .33]

REPORT N° 1

(America)

By C. Peter CLARK,

VICE PRESIDENT AND GENERAL MANAGER, BUFFALO & SUSQUEHANNA RAILWAY.

The subject of motor vehicles holds a prominent place in the consideration of steam railroad officials, because of the changing conditions tending to constantly lose to competing electric lines, business which was formerly done by them.

The great increase in travel by automobile has had a marked effect in encouraging the feeling in travelers that they should be transported whenever ready to make a trip, rather than when a train is scheduled to run, as was formerly accepted as a matter of course.

The comparatively frequent service of electric roads with the light expense per car mile, can be justified by a number of passengers altogether too small to nearly pay the expense necessary to run a standard steam passenger train.

To meet these conditions railroads having established roadbeds and stations, are naturally anxious to protect their investment by retaining as large a percentage of their passenger travel as possible, and to that end are greatly interested in any apparatus promising service at a cost permitting sufficient frequency and speed to hold the business against their competitors.

Interest in the subject has increased as competition has developed or been threatened, and many attempts have been made to produce suitable equipment for this purpose.

Considerable sums have been spent by some large interests without producing cars susceptible of a perfectly satisfactory trial trip, to say nothing of usefulness thereafter and it seems clearly unjustifiable to ask attention to apparatus which has

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not received a substantial approval, unless so recently developed that necessary time has not elapsed for pratical demonstration, excepting when special features are incorporated suggesting ideas that may be useful in future developments.

As the most successful builders are those who study the weak points of their vehicles for the purpose of improving them as use indicates possibilities, it is not difficult to see that in small details the car built at the time of writing will be improved, if only in minor particulars, by the time the Congress convenes, so that enumeration of the small matters of detail would serve no good purpose, while general descriptions will indicate the various types, the very latest details and developments which can always be readily obtained by those particularly interested.

Those small and light cars which have not sufficient size to afford space for the transportation of baggage and frequently better suited for inspection than revenue service, are purposely omitted as outside of the intended scope of the subject.

The last published report of the Interstate Commerce Commission of the United States shows passengers carried one mile for the year ending 30 June 1907 as 27,718,554,030, while the number of passenger train miles run in the same period is given as 509,328,042; this gives the average passengers carried per train mile as 54. When the enormous loading of suburban trains running in the neighborhood of larger cities, as well as the heavy trunk lines trains, are taken into consideration, it is painfully evident that a great mileage is maintained at a serious loss, as all the passengers carried occupy but a small part of one car, while the number of employes and weight necessarily moved, involve a considerable expense.

In many of these cases such as branch lines, the connection with main line trains must be maintained though frequency of service offers no increase, making the problem one of economy in operation.

The successful motor vehicle adapted to steam railroad use should be designed to attract business where it is susceptible of development and operate at low cost to reduce the loss where increased frequency of service will not add to the revenue.

Perhaps the most serious opposition which has so far been discovered by those working upon this subject, is found in the attitude of labor towards a device designed to reduce the number of employes per unit below that formerly required for the steam train.

One of the largest interests in the country has been so embarrassed by the labor legislation introduced both in Congress and some of the state Legislatures, specifying that any train, no matter how short, shall carry a crew of at least five men, that they have decided to await the outcome of the agitation before investing further time or money for the development of apparatus which may be deprived of its usefulness through this short-sided policy.

Apparently the fact that a change in apparatus increasing the number of moving units many fold necessarily requires a total increase in the number of men employed is to be prejudiced because the single unit does not require and cannot, with its small load, afford to pay the wages justified by a steam train with many cars.

As a matter of safety, it seems strange that interurban high speed, heavy electric cars can be run up and down hill in the country highways by two men without question, while the operation of a steam motor car upon the branch line of a standard steam road owning its own right of way and without other train upon the branch, should require five men or be rated as such a dangerous operation as to interest investigation by state railroad commissioners.

The speed freely permitted touring cars in public streets to-day would, a few years ago, have seemed proper only for fire engines or ambulances, and it is to be hoped that as the public become accustomed to seeing a boy of fifteen years handle a heavy automobile in crowded streets, that they will becomereconciled to the thought that two men are sufficient to protect passengers upon motor cars, enjoying exclusively the fenced right of way of a railroad company.

The absurdity of a city government restricting steam trains to a speed of six miles an hour where crossing highways at grade in the suburbs, while authorizing touring cars to run up and down the length of the city streets at ten miles an hour, certainly cannot last and with the inevitable public education, should come a popular support for an honest attempt upon the part of the railroads to give the traveling public a frequent service at a low cost.

Previous experiments have shown that cars should be neither too light nor too heavy. The light car has proved of insufficient power to meet the speed expected and those having too much weight upon the heavy end, that of the motor truck, have shown a tendency to destroy the gauge upon the track of branch lines, which are frequently maintained at a cost per mile considerably below that of the main line.

The various types will be discussed by classes.

A. — Those driven by steam.

B. — Those driven by internal combustion engines with a mechanical transmission of power.

C. — Those utilizing internal combustion engines operating generators in connection with an electric drive, with or without accumulators as incidental equipment.

A. — Motor cars driven by steam. — Fuel coal.

Rock Island No. 2551.

Continuing the earliest experiments along the line of steam motor cars, using coal as a fuel, there has recently been exhibited a car built for the Rock Island Company.

It is an improvement of the Ganz Car which was developed some ten years ago in connection with a boiler generating about 80 horse-power and which proved inadequate for the service required by American railroads.

A modification has been adopted by which additional boiler space is secured until the car now claims a capacity of 250 horse-power, with a maximum speed of 50 miles an hour on level track.

The total weight of the car is approximately 100,000 pounds.

The boiler arrangement adopted consists of a horizontal boiler located immediately above the forward bolster with flues at right angles to the length of the car.

By opening two doors which are located between the side door to the motor compartment and that to the baggage compartment (see fig. 1) the end of the boiler is disclosed and by opening the head, the flue sheet is exposed and flues can be easily cleaned from a platform placed beside the track outside the car.

The engine consists of two simple cylinders, entirely enclosed and is mounted in the front truck, connected to cranks upon the rear axle.

The connecting rods and other working parts are contained within cast steel casings which surround the driving axle and cranks and contains oil to insure continuous and automatic lubrication of all working parts.

The valves are of piston type and cylinders 12 × 12 inches. The valve motion is of the modified Hackworth type and all wheels are 36 inches in diameter.

The boiler contains 294 tubes of 1 $^3/_4$ inches about 5 feet long. Total boiler heating surface 700 square feet, with an additional 125 square feet in the superheater of the fire tube type, placed circumferentially around the upper half of the front portion of the boiler. The boiler carries 160 pounds pressure per square inch.

The grate area is 14 square feet and suitable for either hard or soft coal.

Sufficient fuel for 100 miles is carried in a bunker at the front end, and water tanks with a capacity of 1,000 gallons (a supply for 50 miles) are placed beneath the car.

The engineer's compartment is equipped with all necessary valves and control mechanism including air pump, pneumatic sander, pneumatic bell ringer, etc.

Immediately behind the engineer's compartment which contains the boiler, is a small baggage room, about 7 feet long, behind which is a smoking-compartment seating eight, with seats for 40 in the body of the car.

The car illustrated in figure 1 was built for the Rock Island Company with an all steel body which is upholstered in rattan, lighted by acetylene, contains a toilet and has a vestibuled entrance at the rear opening from both sides.

This improved car with 250 horse-power boiler has not yet seen sufficient service to furnish any data as to the cost of operation.

This car was built from designs of the Railway Auto Car Company of New York City by the Baldwin Locomotive Works of Philadelphia.

Motor cars driven by steam. — Fuel oil.

Rock Island No. 2552.

In motor cars where weight is so undesirable and the labor of carrying and handling bulky fuel so objectionable, oil as a fuel offers an attractive study, which was developed by the American Locomotive Company for motor car number 2552 of the Rock Island System.

As seen in figure 2, the car in general appearance and arrangement is much like the one previously described, although, as will be seen from the cut next following, the 250 horse-power engine is of an entirely different design, being in brief a small locomotive with a single pair of 38 inches drivers, operated by the Walschaerts valve gear.

The car is 56 feet long and weighs 100,000 pounds of which, 61,700 pounds is on the motor truck (see fig. 3) with a trifle over half upon the driving wheels. This car has attained a speed of 60 miles an hour and as oil is used for fuel, the labor required of the engineer is much reduced.

The car body is entirely of steel except the interior finish, and is built in the interest of lightness with truss rods to assist in reducing vibration to be expected from the tanks carrying 1,000 gallons of water and 100 gallons of oil.

The boiler is of the horizontal return tube type, the fire and smoke box both being on the front end, the gases of combustion passing from the fire box through the lower half of tubes to an intermediate smoke chamber at the back and thence forward through the upper tubes to the smoke box and stack.

The barrel of the boiler is 61 $^1/_8$ inches long and 49 inches in diameter at the fire-box and and 44 inches in diameter at the rear.

The boiler contains 428 tubes of 1 $^1/_4$ inches in diameter about 3 feet and 10 inches long. The heating surface of boiler is 566 square feet, superheater 38 square feet, total 624 square feet.

The superheater is located in the intermediate smoke box chamber upon the rear where the temperature of the gases is high. Each of the 16 superheater tubes bent into loop are connected with the front or saturated steam compartment on one end, and the superheated steam compartment at the other.

The interior of the fire-box is lined with brick for burning oil which is introduced through a burner of special design in the fire door (see fig. 4).

The engine is of the two-cylinder cross compound type, cylinders 9 $^1/_4$ inches and 14 $^1/_2 \times$ 12 inches. The Mellin system of compounding being employed. The springs of the driving truck are arranged to give three point suspension.

The car may be lighted by oil, Pintsch gas or acetylene as desired.

B. — Motors cars driven by internal combustion engines with a mechanical transmission of power.

McKeen Motor Car.

With the development and simplification of the internal combustion engine, producing in small space power both efficient and reliable, as illustrated by the now infrequent failures of the first class automobiles, naturally comes the thought of application to the motor car.

Instantly ready, clean, tireless and compact, it promises many extremely desirable features.

In 1904, the Union Pacific decided to experiment towards the development of a car using gasolene, which should meet the recognized requirements of a successful motor car.

Since the completion of the first car in 1905, the same interests have continued experimenting, improving and building motor cars of this description, but the demand for the car soon required more space and attention than could be given in the regular shops of the Union Pacific and the superintendent of motive power of that company, Mr. W. R. McKeen, resigned from the service of the Union Pacific and organized a company with works at Omaha, Nebraska for the exclusive building of equipment of this class.

Although several different types have been built in the last four years, they have simply shown the evolution of the original idea.

The first car was 31 feet in length, mounted upon one four wheel truck.

The cars now being built (see fig. 5) are 70 feet in length with compartments for engine, baggage, railway post office, if desired, smoking compartment and passengers.

With the pointed front, the wind resistance is appreciably reduced and the consumption of gasolene correspondingly lowered.

The shops fitted for the building of these cars have been provided with special machinery for the purpose of making parts interchangeable and by the most improved methods, so that by the use of the best material, failures and breakage upon the road shall be minimized.

The fact that the entire works are given over to the manufacture of these cars has produced, in four years, improvements which could not have been expected in a much longer time, had the building of an occasional car been an incident in shops maintained for other classes of work.

The interior partitions are, of course, dependent upon the requirements of the service and locality. It is quite generally considered necessary to provide facilities for handling baggage with the passengers, so that practically all cars are equipped with baggage room, unless the amount of baggage and express justifies the hauling of a trailer, when the car itself can, of course be devoted exclusively to the seating of passengers.

Fig. 1. — Rock Island steam motor car No. 2551.

Fig. 2. — Rock Island motor car No. 2552.

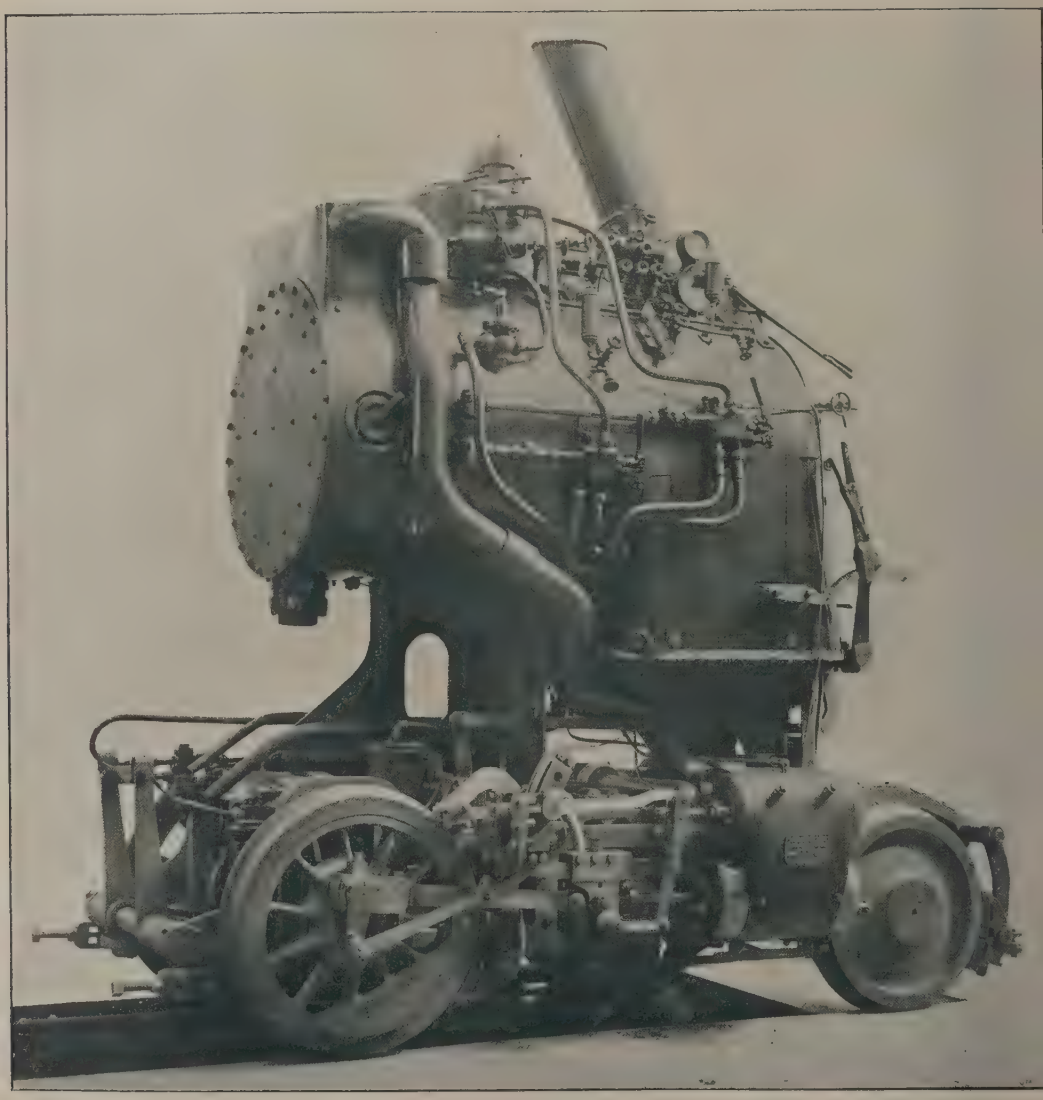

Fig. 3. — View of boiler and engine, Rock Island No. 2552.

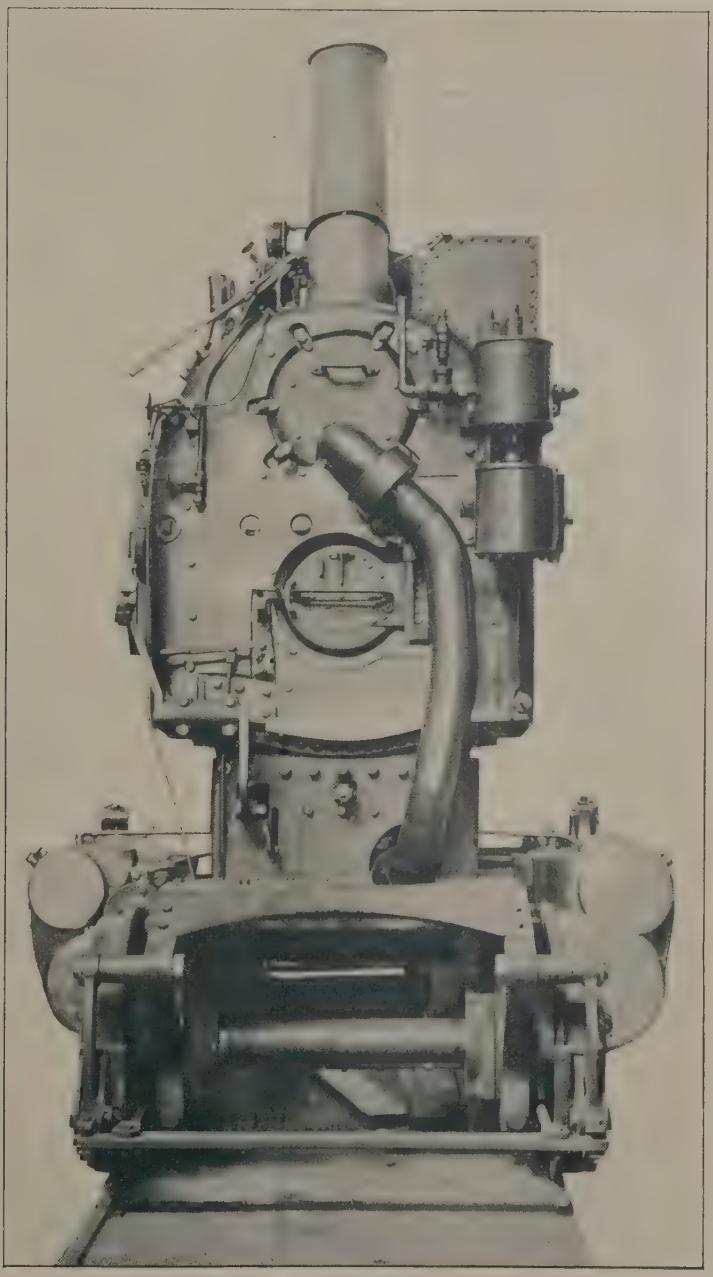

Fig. 4. — View of boiler and engine, Rock Island No. 2552.

Fig. 5. — McKeen motor car.

If an entire 70-foot car is furnished with seats, it may carry as many as 105 persons, practically double the average train load of the United States and with the 200 horse-power engine on any reasonable grade, no difficulty is found in handling a trailer at satisfactory speed.

What appears as the accepted arrangement for motor cars is followed, the engineer and engine, occupying the front of the car, which is carried upon a four wheel truck as shown in figure 6.

The six vertical cylinders are placed over the center of the truck and drive a shaft located between and parallel to the axles of the front truck.

Connection between the engine axle and the axle carrying the driving wheels is made by a five-inch silent-running chain, plainly seen beside the friction clutch on center of front axle.

Compressed air is used to start the large engine as well as for brakes, elevation of gasolene from tanks below the car to the engine, whistle, etc.

The air is supplied by a small and compact air compressor, which is started easily by hand.

The stored air from the reservoir is admitted to the regular cylinders until the carbureter charges the engine sufficiently to commence explosions.

After the engine is started, the friction clutch working in connection with the counter shaft giving powerful low speed applies the power to start the car, after which the counter shaft is disconnected and speed manipulated by increasing or decreasing the supply of gasolene. This low speed connection is used only in starting and moving the car about its length. There are no gears in service except during this brief period.

The six cylinders of the standard engine rated as 200 horsepower, are 10 inches in diameter with 12 inch stroke.

The cylinders have water jackets cored in the casting, the water being cooled by radiators under the car in hot weather and as much as may be desired, used for heating the car in cold weather.

One of the cars in switching service handled a 40-ton car of coal weighing 111,300 pounds, gross, upon a trestle up an 8 per cent. grade, while upon level track, speed up to 79 miles an hour has been made.

The weight of this 70-foot car in working order, is 68,000, about 42,000 pounds of which is upon the front truck and approximately 25,000 pounds upon the 42 inch drivers, which are the lead wheels of the front truck.

The weight of the 55-foot car is 60,000 pounds.

Light is either by acetylene from special designed generator, or commercial stored acetylene.

These cars on long runs fully equal, and frequently exceed the speed of express trains, and the distance covered between terminals is materially in excess of locomotive practice.

There were, in June 1909, forty-six cars in service in different parts of the country,

between the Valley of the Hudson River and the Pacific Coast. Fourteen additional cars built on order are substantially completed and ready for service at the present time, making a total of 60. Material is also being assembled and work commenced on 20 additional orders.

The efficiency figures furnished by the Union Pacific Railroad which have had a number of the cars in use for several years, including some of the earlier ones, report but 61 failures out of 9,883 motor car trips, most of which were due to breaking in of inexperienced men, although the car appears to be easily understood by a man of ordinary mechanical intelligence. One car, No. 19 upon the Union Pacific Railroad completed an even year's daily service, hauling regularly a trailer and had but two failures of the engine, during that time.

C. — Motor cars utilizing internal combustion engines operating generators in connection with an electric drive, with or without accumulators as incidental equipment.

General Electric Company's Car (fig. 7).

The evident demand for satisfactory motor cars shown by the interest taken in all developments announced through the railroad journals, have enlisted the attention of the General Electric Company, representing the same general interests as the Thomson Houston Company abroad.

They believe that the production of steam as a source of power is unnecessary and have adopted an 8-cylinder, 4 cycle gasolene engine of 125 horse-power at 550 revolutions per minute direct connected to an 8 pole 80 kilowatts 600 volts commutating pole generator and direct coupled with $3\ ^1/_2$ kilowatts 32 volts exciter (see fig. 8).

The cylinders are 8×8 inches with water jackets cored in close grained grey castings and are cooled by thermo siphon circulation, having radiation of 2,000 square feet surface located on roof of car.

The bearings throughout consist of bronze cages lined with babbitt. All valves are of nickel steel.

Automatic force feed lubrication is applied to all wearing surfaces.

Ignition is by high tension magneto and plugs, gasolene being supplied by a plunger pump directly driven by the engine.

The gasolene is carried in a steel tank holding ninety gallons, located below the car floor and is filled from the outside.

Power is applied to both pairs of wheels of the forward truck through two 600-volts 100 horse-power railway motors.

A special controller is furnished by which the motors are placed progressively in series and parallel, and the voltage applied to them controlled by varying the strength of the generator field.

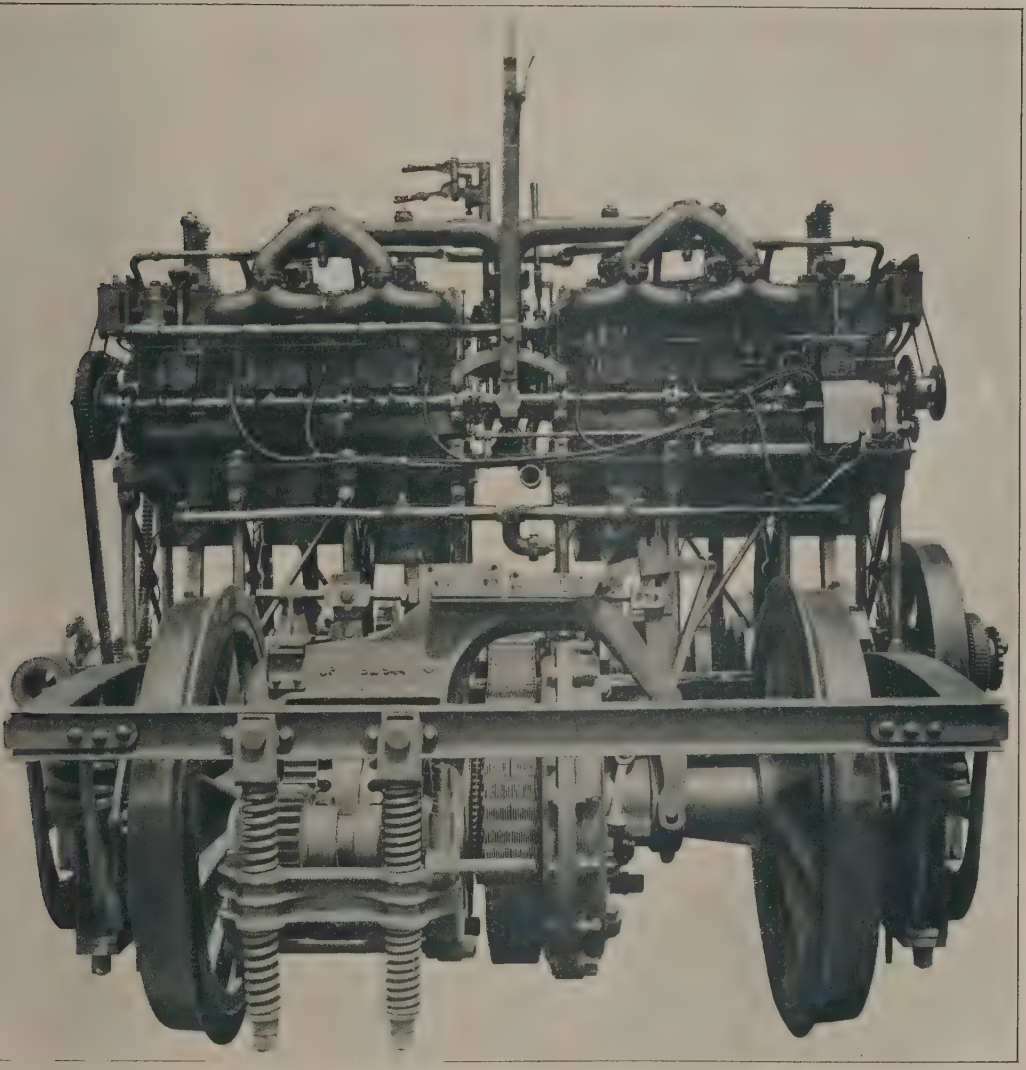

Fig. 6. — McKeen motor truck. — Front end.

Fig. 7. — General electric Company car.

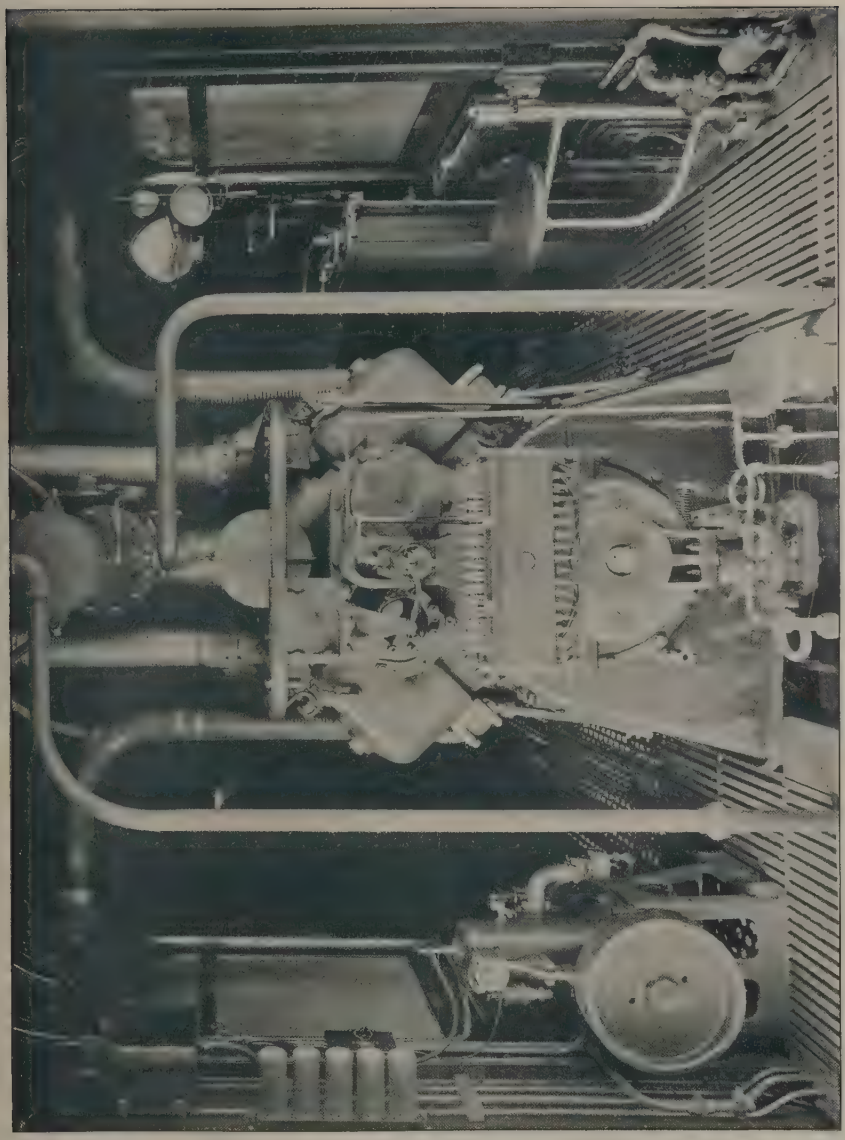

Fig. 8. — Interior of cab. — General electric car.

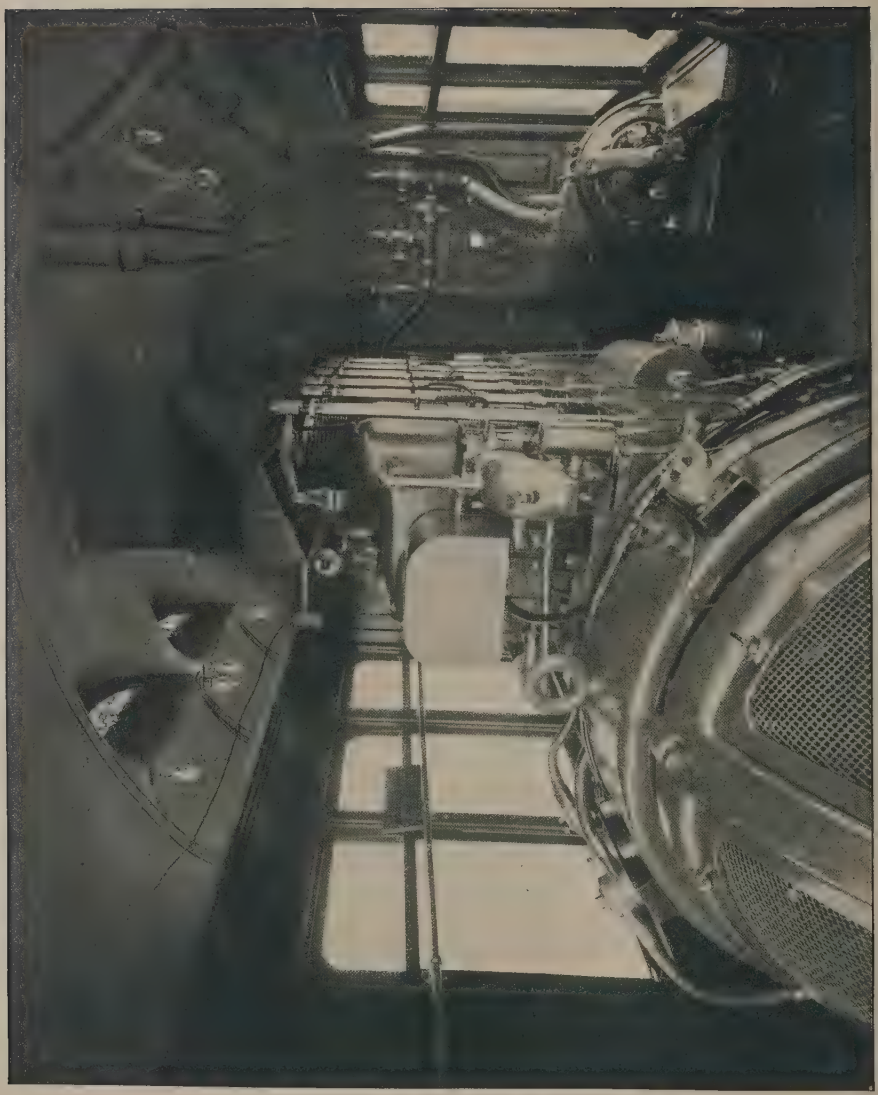

Fig. 10. — Car Irene. — Interior of engine compartment from the front end.

If desired, the car can be furnished with trolley for city work, using the same motors.

The car is finished with the usual equipment for controlling the air brakes, electric lights, whistle, gong, etc.

Compressed air is used to start the main engine through admission to the main cylinders and is regularly furnished by a small 4 × 4 inch single cylinder pump driven from the main crank shaft. If the car stands long enough to lose its supply of stored air, it can be charged by a small independent pump.

The car can be started, stopped and reversed without stopping the engine, and by a simple arrangement of the circuits, the power furnished the motors is under such control that the greatest flexibility is obtained, such as might be obtained with an unlimited number of gears but without the objectionable jar frequently occuring when gears are changed.

The car is electrically lighted by 25-volt incandescent lamps taking power from the exciter when car is running, and from storage battery below the floor when engine is shut down.

Car is heated by hot water circulation utilizing the exhaust gases.

The weight of the car exhibited at Atlantic City in June 1909 which measures 50 feet over all with steel body is given as 70,000 pounds, of which about 45,000 is on the motor truck.

Strang gas-electric car.

A different arrangement of the gasolene engine for electric production and application using accumulators is shown in the Strang Gas-Electric Car Irene (fig. 9).

As a substitute for the mechanical transmission of power direct to the drivers, the Strang Gas-Electric Car Company of 15, Wall Street, New York, have built four cars each of which is furnished with a generator of about 150 horse-power at 425 revolutions per minute, furnishing electric power.

A vertical 4-cycle type engine with 6 cylinders, 10 1/2 × 9 inches in connection with a generator of 85 kilowatts furnish direct current at 250 volts.

The power is applied to both axles of the front truck by 100 horse-power motors. When not in motion, any surplus current generated is stored in a battery of 112 cells, having a capacity of 300 ampere hours.

High grade material has been utilized and all the main working parts are located in the crank case which is completely enclosed to retain oil and exclude dirt. The various bearings are oiled by means of a rotary gear pump. Ignition is of the high tension type.

The cylinders are jacketed for water circulation connecting with radiators upon the roof which is designed so as to conceal them. The circulation is secured by a turbine pump driven by independent 2 horse-power motor, shown at right.

A view of the engine located in the front compartment, which is 14 feet long gives a general idea of the mechanical arrangement (fig. 10).

The passenger compartment is heated in cold weather by the circulation of hot water from the cylinder jackets and lighted by electricity.

In addition to three located upon an interurban line in Kansas, the Company has demonstrated its system by the car Irene herein illustrated.

The Irene measures 62 feet over the bunters. The car body is built of steel finished handsomely with vermillion wood, inlaid.

The weight of the car is 114,000 pounds and has a seating capacity of 41 passengers, one half of which are given individual chairs which increase comfort, although decreasing capacity.

In starting the car or negotiating heavy grades, the electricity in storage battery is available to supplement the work of the engine through the generator and thus carries the "peak" furnishing results which would otherwise require a larger and heavier engine and generator.

While this car has traveled a great many thousand miles for exhibition and given tests upon different roads, it has not been in continuous service in any one place long enough to determine the actual cost of repairs and renewals of such features as the storage battery.

The car upon the Pennsylvania Railroad tracks is said to have made a mile in 57 seconds, with about the same speed under general service conditions as an ordinary steam train.

SUMMARY AND CONCLUSIONS.

The fact that interest in this subject continues on every side and that different roads and Companies continue to produce new types of apparatus upon the same general line is a very encouraging sign.

The question of expense, first cost of repairs and depreciation cannot be satisfactorily determined by the performance of isolated cars under different weather and topographical conditions where the prices for the same kind of fuel and service vary greatly.

The marked tendency of the past three of four years based upon the numbers built, is unquestionably in favor of the car operated by gasolene and without the additional electrical complications, but this, by no means, proves that the experiments of the next three or four years may not introduce new features giving even more satisfactory apparatus at ess cost and susceptible of even cheaper operation.

The amount at stake is so large that the continued study of the subject is clearly warranted, and circumstances appear to justify the belief that apparatus of this kind alone will enable steam railroads to protect passenger business which otherwise will be lost to them.

[621 .132 8 & 621 .33]

REPORT N° 2

(all countries except Great Britain and America)

By L. GREPPI,

DIVISIONAL INSPECTOR OF THE ITALIAN STATE RAILWAY.

General considerations.

The list of questions, which is given in appendix I, was addressed to seventy-four railway administrations, forty-three of whom sent us answers.

Twenty-six administrations stated that they had no automotor cars or equivalent small locomotives in use at present, that they had never had any, and that they did not intend to have any built.

The answers we can utilize in discussing the subject, are thus reduced to seventeen, some of which give very detailed information about the different points touched upon in the list of questions, and others only give information about some of them.

Although the information officially collected is of considerable extent, yet it cannot be considered complete, as the answers we have received do not include all the administrations which have motor vehicles in use.

The question considered has lately been the subject of several interesting publications, and we have been able to consult with advantage the information contained, more especially, in the *Handbuch für Triebwagen für Eisenbahnen* by Mr. C. Guillery, State Councillor, of Munich (1), and in *Motorwagen und Lokomotive*, by K. Spitzer, chief engineer, of the Austrian Northern Railway, and Dr. Victor Krakauer, secretary of the Austrian Northern Railway (2).

(1) Published by R. Oldenbourg, Munich and Berlin, 1908.
(2) Published by A. Holder, Vienna, 1907.

The question of automotor cars was also fully discussed at the XV International Congress of tramways and light railways, which met at Munich in September 1908; the very interesting and very complete report of Mr. E. A. Ziffer, civil engineer, president of the Council of administration of the railways of local interest of Bukovinia (1), which is the most recent work on the subject, has been very useful to us, the more so as it contains detailed information not only about services of automotor cars and of small locomotives on secondary railways, but also about applications of this system of operation made by several of the main-line railways. Mr. Ziffer's report retains its full value, the development of the application of automotor cars having made no appreciable progress since its publication.

In order to be as complete as possible, we have, in the report which follows, utilized the information taken from the above works which supplements the answers received to our list of questions.

Moreover, detailed descriptions of the most recent types of automotor cars have appeared in the technical reviews of the last years, which can be usefully consulted by those more especially interested in the details of construction of such cars. The types used may be considered sufficiently well known today in the technical world to relieve us from giving much space to the descriptive part, and to enable us to limit our investigations to points in connexion with the working.

Our list of questions, which is given in appendix I, was drawn up in such a way as to enable us to consider the very different types of automotor cars on the railways of the continent of Europe, specially from the point of view of conditions of operation, without neglecting the trials which have been made to replace automotor cars by small locomotives, particularly by such locomotives especially designed for this purpose.

In our report, we have classed with the automotor cars the motor luggage-vans, which have externally the appearance of an ordinary luggage-van, such as the motor luggage-vans of the Italian State Railway. On the other hand, we have considered as locomotives the motor luggage-vans of the French State Railway, which have the appearance of a true tank locomotive with a large cab which includes a compartment for luggage.

We have not considered the electric cars taking current from outside, for as they are dependent on fixed installations for generating and transmitting the energy they belong to the problem of electric traction, which is outside the scope of our present subject.

The twenty-six administrations which informed us that they have no automotor cars in use or on order are the following :

Alsace-Lorraine State Railway;
Oldenburg State Railway;

(1) Published by the *Union internationale des tramways et des chemins de fer d'intérêt local*, Imprimerie des travaux publics, Brussels, 1908.

Bukovinia Local Railway;
Austrian North Western Railway;
Mohacs-Pecs Railway (Hungary);
Belgian Northern Railway;
Danish State Railway;
Bulgarian State Railway;
Egyptian State Railway;
Andalusian Railway;
Madrid-Caceres and Spanish Western Railway;
Spanish Northern Railway;
French Eastern Railway;
French Midi Railway;
Compagnie générale des chemins de fer et tramways (Paris);
Gafsa Railway (Tunis);
Dutch State Railway;
Portuguese State Railway;
Nicolas Railway (Russia);
Moscow-Kursk-Nijni and Mourom Railway (Russia);
Sizran-Wiazma Railway;
Trans-Caucasus Railway;
Trans-Baical Railway;
Swedish State Railway;
Norsk-Hoved Railway (Norway);
Rhetian Railway (Switzerland).

The seventeen other answers to the list of questions may be subdivided as follows :

The Baden State Railway made trials in 1901 with a Serpollet steam car and an electric accumulator car, now no longer used; at present it does not intend to make any other application.

Three administrations (Teplitz Railway, French Western Railway, Norwegian State Railway) do not use automotor cars, but they state that they have established several local services which are operated with small tank locomotives, *of old type*.

The following thirteen administrations are at present using automotor cars of different types :

Bavarian State Railway;
Saxon State Railway;
Wurtemberg State Railway;
Austrian State Railway;
Austrian Southern Railway;
Belgian State Railway;

Belgian National Suburban Railway Company;
French State Railway;
Paris-Orleans Railway;
Paris-Lyons-Mediterranean Railway;
St. Quentin Departmental Railway;
Swiss Federal Railway;
Italian State Railway.

I. — Type and particulars of the automotor cars used.

The principal data and particulars supplied by the administrations consulted, concerning the different types of automotors cars, and the small locomotives used for similar services, are reproduced in a table in appendix II.

Class of motor. — As we have already stated, thirteen administrations, out of the seventeen which sent us affirmative answers, are at present using automotor cars.

Of these thirteen administrations, ten use steam motors, while three have in succession given up their use; these are the Saxon State Railway, the Swiss Federal Railway, and the Belgian Suburban; the two former had tried Serpollet cars and the latter Rowan cars.

Internal-combustion motors, with mechanical transmission of the motion to the wheels, are utilized by four administrations : the Saxon State, the Swiss Federal, the Wurtemberg State and the Austrian State; these use in current practice both cars with petrol motors as well as cars with steam motors of different types.

These four administrations also use one and the same type of car and of internal-combustion motor : the Daimler petrol motor.

The system of cars having an internal-combustion motor, combined with an electric transmission of the motion, that is to say, with a dynamo driven by the internal-combustion motor, and electric motor fed either direct by the dynamo, or through a battery, is not in current use by any of the administrations which have sent us answers. The Belgian Suburban however informs us that it is just about to try a *mixed system*, in which the cars are equipped with a petrol or lean-gas motor (the gas-producer being carried on the car), dynamo, accumulators and electric motors, designed by the *Compagnie internationale d'électricité de Liége*.

The administration of the Italian State Railway, at the time of the Milan exhibition, made two trial runs with a benzo-electric automotor car on the Weitzer system, belonging to the Arad-Csanàd Railway; this car has two axles, with a 70-horse-power de Dion-Bouton petrol motor; but the system, which appeared to be a little complicated and delicate, has not been applied, in spite of the favourable results of the two trial runs.

Mr. Guillery's book, mentioned above, and Mr. Ziffer's report to the Munich Congress however show that the Weitzer mixed system has been applied rather exten-

sively on the Arad-Csanàd Railway, and that it is being tried on the Hungarian State Railway. A car with petrol motor and electric motor, of a special type, is going to be tried on the Prussian State Railway.

Electric accumulator automotor cars are used by three of the administrations which sent answers to our list of questions : the Bavarian State, the Saxon State and the Belgian State railways. Each of these administrations has but one automotor car of this system in use, so that these applications are rather of the character of mere trials.

The Italian railways, during the period 1900-1904, used accumulator cars of two types, one for the local service on the Milan-Monza line, the other for the whole passenger service on the Bologna-San Felice-Poggio Rusco line. These automotor cars were then withdrawn from the service and transformed into ordinary carriages, owing to the cost of upkeep of the first of the two types, and to the unforeseen development of the traffic in the case of the second type.

We believe that the Wurtemberg railways also formerly used accumulator automotor cars.

Among the administrations which sent no answers to our list of questions, but which are at present using accumulator automotor cars, we may mention the Prussian State Railway, which uses a considerable number (see Messrs. Guillery and Ziffer, *op. cit.*).

As regards the total number of units *actually* used on the railways from which we have received answers, we find :

185 automotor cars with steam motor;
7 automotor cars with internal-combustion motor;
3 electric accumulator automotor.

To these figures, we must add the benzo-electric automotor cars, and cars of other similar mixed systems, which are being tried in Belgium and are being used on railways which have sent no answers to the list of questions, as well as the Prussian State accumulator cars, which we have mentioned above.

It follows from what we have stated, that from the point of view of the qualities specially required for automotor cars, and the services for which they are used, there is at present a tendency to extend investigations and experiments on the subject of cars with petrol motors or benzo-electric motors, or with accumulators; it seems, however, that a solution which is entirely satisfactory for current applications has not yet been obtained, and consequently steam automotor cars are still the most used in spite of the almost inevitable disadvantages inherent in the different types of this system.

Number and arrangement of the axles. — The automotor cars at present in use have two, three or four axles.

Limiting ourselves to the data supplied by the administrations which sent answers to our questions, we find that the following are at present in use :

—	With steam motor.	With petrol motor.	With accumulators.
Automotor cars with 2 axles	34	7	1
— 3 —	122	...	...
— — 4 —	29	...	2

The use of two axles when internal-combustion motors are used, is explained by the generally limited power of motors of this system used at present in Europe on automotor cars.

In the case of steam automotor cars, there is an evident tendency to prefer cars with three or four axles, in order to make it possible to get a motor sufficiently powerful to have the necessary flexibility in the service and also to make it possible to increase the capacity of the car. The same consideration applies to electric accumulator cars.

In the case of the two-axle automotor cars, the wheelbase varies between 4 and 6·320 metres (13 ft. 2 in. and 20 ft. 9 in.); in the case of the larger wheelbases, radial axle-boxes are used, to facilitate running round curves. All these cars have one driving axle only; the second is simply a carrying axle, except in the case of the Bavarian two-axle accumulator car, where the two axles are independent, but are both driving axles.

The three-axle cars are most numerous; they are of five types, which as regards the arrangement of their axles, may be classified as follows :

a) The old Belpaire cars of the Belgian State Railway, first pattern, and the motor luggage-vans of the Italian State Railway, series 60 (classed in the present report with the automotor cars, as stated above); these have a shorter wheelbase which is quite rigid, of 4·100 and 4·600 metres (13 ft. 5 $^{7}/_{16}$ in. and 15 ft. 1 in.) respectively (see fig. 1). The driving axle is in the middle and coupled to the leading axle; the trailing axle is only a carrying axle;

b) The Purrey car of the Orleans Railway, series AV 1, with a wheelbase of 8·200 metres (26 ft. 10 $^{7}/_{8}$ in.). The driving axle is in the middle; the two others are simply carrying axles and are fitted with axle-boxes with side play for running round curves;

c) The Purrey car of the Orleans Railway, series AV 2-11, and that of the Paris-Lyons-Mediterranean, series VACE/21-32 (fig. 2), which consist of two parts :

1° A motor truck with two axles; its frame, which is separate from that of the car, carries the boiler and motor, as well as the water and fuel supply;

2° A carriage body, with one end supported on the motor truck and the other on a trailing axle. The wheelbase of the motor truck is 3·200 metres (10 ft. 6 in.); only the second axle is a driving axle. The total wheelbases of the cars are 11·400 and 12·400 metres (37 ft. 5 in. and 40 ft. 8 in.), for the cars of the two railways respectively; the distances from the centre of the truck to the trailing axle are 9·500 and 10·500 metres (31 ft. 2 in. and 34 ft. 5 in.) respectively.

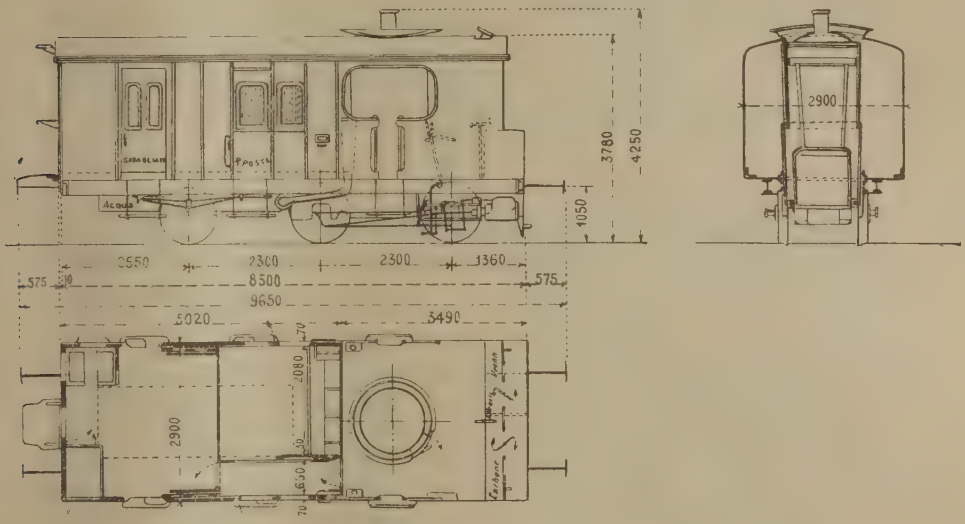

Fig. 1. — Italian State Railway. — Motor luggage-van, series 60.

The four-axle automotor cars have varying wheelbases; the maximum is 16·240 metres (53 ft. 3 3/8 in.) (cars series 86 of the Italian State Railway).

Among the four-axle steam cars, the old Belpaire cars of the Belgian State Railway, second pattern, alone have the four axles mounted on one and the same frame, which is also that of the car. The two leading axles are coupled, the third and fourth are carrying axles; the latter has radial axle-boxes. The rigid wheelbase is 4·600 metres (15 ft. 1 in.) and the total wheelbase is 9·660 metres (31 ft. 8 in.)

The other four-axle steam automotor cars, which are of five types, all consist of two separate parts, similar to the three-axle cars with independent motor truck, of the Purrey type mentioned above. The frame of the motor truck carries the boiler and the engine, thus forming really a separate machine. The body of the car is supported on the motor truck at one end and on a carrying trailing bogie at the other. The two axles of the motor truck are coupled on the automotor cars of the Bavarian State Railway, series MCCi (fig. 3) and on those of the Italian State

Railway, series 86 (fig. 4). On the other hand there is only one driving axle on the DWss automotor car of the Wurtemberg State Railway and on the cars, series 85, of the Italian State Railway (fig. 5). No information is given on this subject as regards the four-axle cars of the St. Quentin Departmental Railway.

These latter cars, as well as the four-axle, series DWss cars of the Wurtemberg State Railway, are narrow gauge (see appendix II). All the others considered in this report are standard gauge.

As regards the two types of four-axle accumulator cars, that of the Belgian State is on two bogies, as usual, and two of the axles are driving axles; that of the Saxon State consists of two half-cars each with two axles, which are permanently connected by an articulated junction; the frames of the two half-cars bear on the axles direct.

Weight of the automotor cars. — The weight of the two-axle steam automotor cars, empty, varies between a minimum of 13 tons (12·8 English tons) (car of the Ganz type, with de Dion motor and boiler, of the Bavarian State Railway) and a maximum of 21·4 tons (21·1 English tons) (Komareck car, 1001, of the Austrian State Railway).

In the case of the three-axle steam cars, the minimum is 19·8 tons (19·5 English tons) (Belpaire car, first pattern of the Belgian State Railway) and the maximum is 29·8 tons (29·3 English tons) (Purrey car, Paris-Lyons-Mediterranean Railway).

The weight of the four-axle steam cars (excluding the narrow-gauge types of the Wurtemberg State and of the St. Quentin Departmental Railways, and the old Belpaire cars, second pattern, of the Belgian State Railway, which weigh only 24·1 tons [23·7 English tons]) varies between 38·5 tons (37·9 English tons) (cars, series 85, of the Italian State Railway) and 43 tons (42·3 English tons) (cars, series MCCi, of the Bavarian State Railway).

The corresponding limits of the weights in working order, but without passengers, luggage or mails, are as follows :

Cars with 2 axles	14·4 to 24·2 tons	(14·2 to 23·8 English tons).
— — 3 —	23·6 to 32·8 —	(23·2 to 32·3 —) (1).
— — 4 —	42·5 to 48·0 —	(41·8 to 47·2 —).

The petrol cars, which as stated above are all Daimler cars, with two axles, weigh empty between 13·1 and 16·3 tons (12·9 to 16·0 English tons); the petrol supply does not increase the weight by more than 200 kilograms (440 lb.) as a maximum.

The two-axle accumulator car of the Bavarian State Railway weighs 26·8 tons (26·4 English tons); the four-axle one of the Saxon State Railway weighs 44·4 tons (43·7 English tons).

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(1) This maximum refers to the motor luggage-vans series 60 of the Italian State Railway.

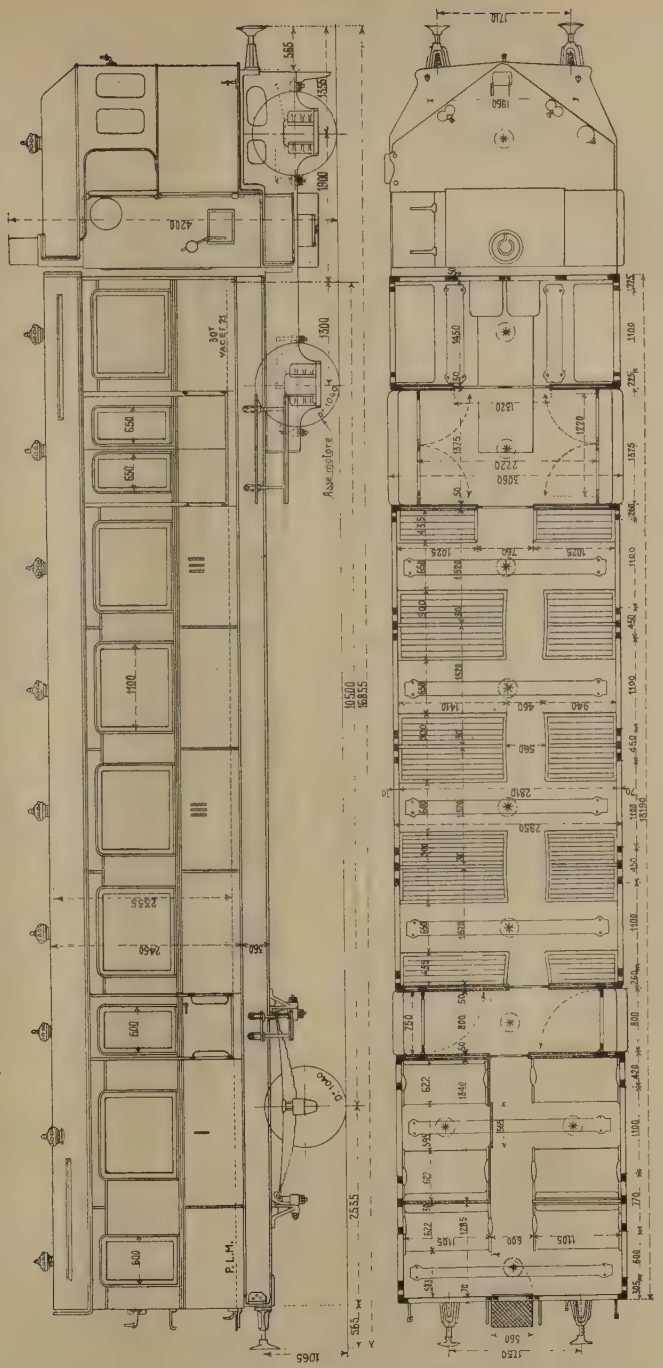


Fig. 2. — Paris-Lyons-Mediterranean Railway. — Purrey steam car.
Explanation of Italian terms : Asse motore = Driving axle.

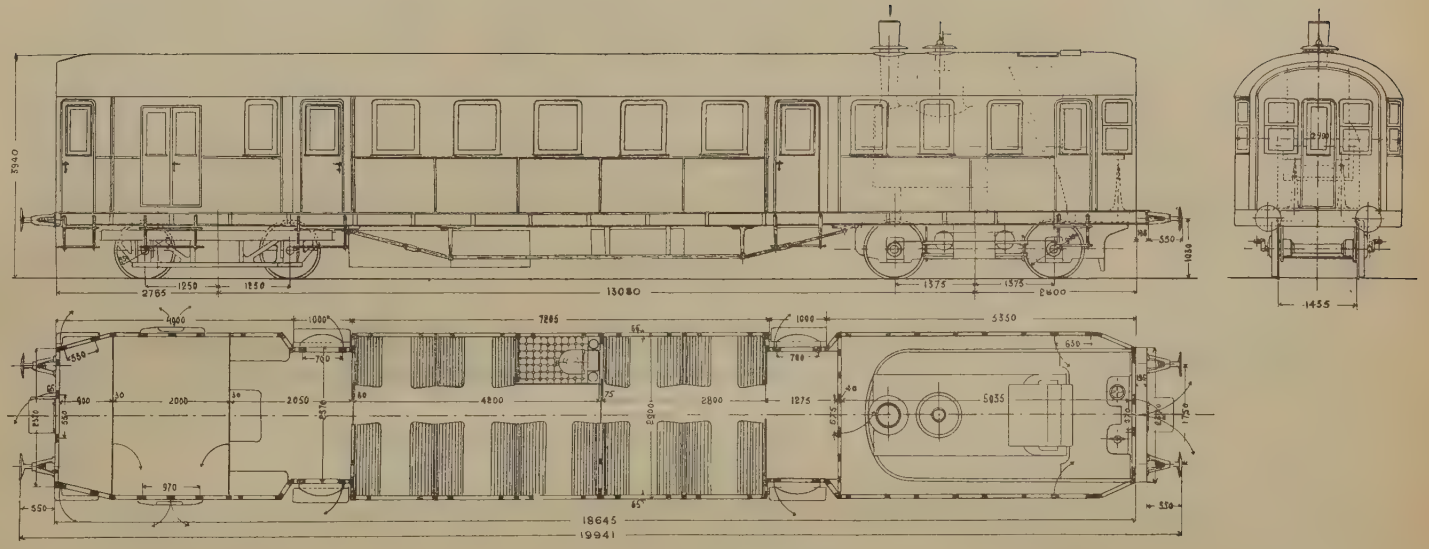


Fig. 3. — Bavarian State Railway.
Steam car with locomotive type boiler and Maffei engine. Series MCCi.

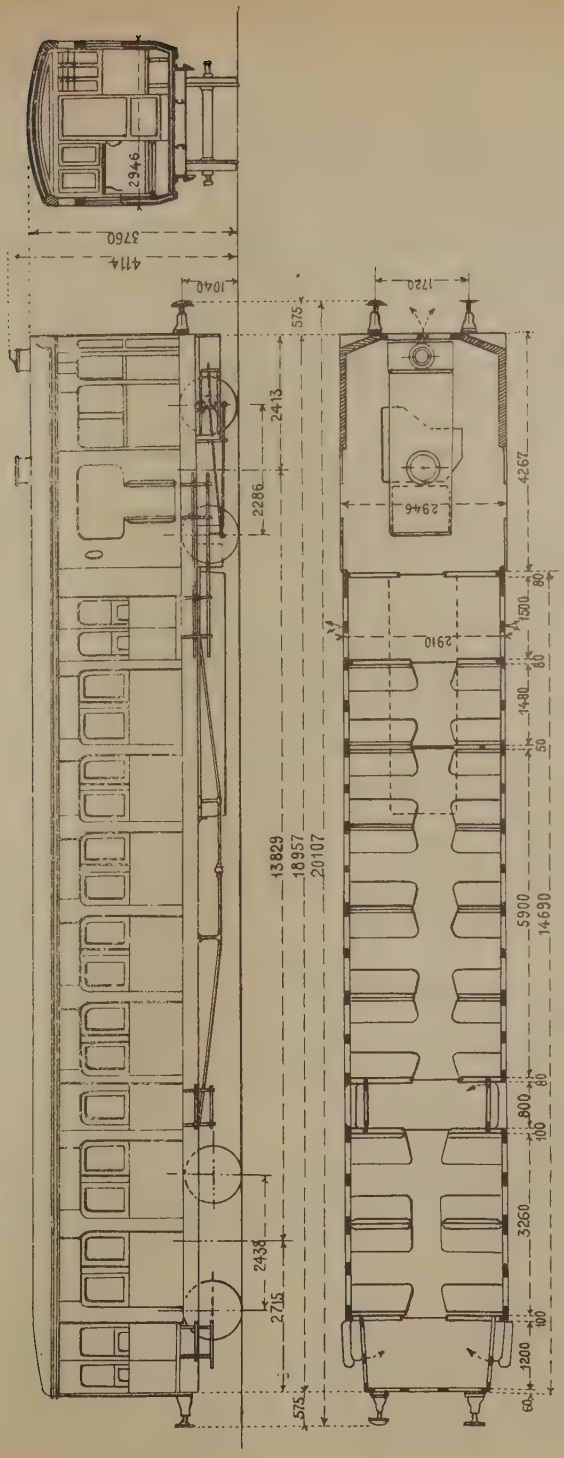


Fig. 4. — Italian State Railway. — Kerr-Stuart steam car with longitudinal boiler. Series 86.

The total service weights, including passengers and luggage, of the automotor cars of the different types are given in the table in appendix II. The lightest cars are those with petrol motors; the heaviest are the four-axle steam cars of the Bavarian State Railway.

The maximum axle-load, excluding the petrol cars and the old Belpaire cars of the Belgian State Railway, reaches or exceeds about 11 tons (10·8 English tons) in all the cars that we are considering.

The lower limit is found in the cars of the Ganz type, with de Dion boiler and motor. The Serpollet, Purrey, Kittel and Komareck cars have maximum axle-loads which vary between 12 and 14·5 tons (11·8 and 14·3 English tons). The motor luggage-vans, series 60, of the Italian State Railway, have a load of 12·5 tons (12·3 English tons) on the driving axle. The highest values are shown by the large steam cars of the Bavarian State Railway (series MCCi) and of the Italian State Railway (series 85 and 86) with two bogies; the loads on the driving axles of these cars are 15·5, 15 and 15·8 tons (15·3, 14·8 and 15·6 English tons) respectively.

Number of classes and of seats for passengers, load-limit. — As regards the number of classes, the one hundred and ten (1) passenger cars belonging to the administrations which sent answers to our list of questions are classified as follows :

a) Forty-five cars, representing eleven different series, have one class only, generally the third. On the cars of the Wurtemberg State Railway, the one class is called the fourth class. Only in the case of a car of the Purrey type, belonging to the Orleans Railway, is the one class the first class; this car is intended always to haul ordinary third-class carriages;

b) Sixty-two cars, representing seventeen series, have two classes (first and third, or second and third);

c) Three narrow-gauge cars, with four axles, of the St. Quentin Railway, have three classes.

On most of the automotor cars, a certain amount of standing room is provided, generally on the platforms at the ends.

The minimum number of passengers per car is 15, but this exceptional figure only applies to the old three axle Belpaire cars, first pattern, of the Belgian State Railway.

The AV1 Purrey car, also with three axles, of the Orleans Railway, which has first class only, takes 26 passengers.

The Purrey car of the Italian State Railway, with two axles, has 24 seats, first and third class, and also standing-room for 10 passengers, together with a very large luggage compartment. In the other two-axle steam cars, the number of seats

(1) This number naturally does not include the eighty-five motor luggage-vans of the Italian State Railway.

varies between 32 and 41. In the two axle petrol cars, the number of seats is relatively greater; there are from 44 to 46 seats, except in the case of the Daimler car of the Austrian State Railway, where there are only 28 seats.

The two-axle accumulator car of the Bavarian State Railway contains 36 seats.

In the three-axle steam cars, series AV2-11, of the Orleans Railway, and in those of the Paris-Lyons-Mediterranean, there are 55 and 59 seats respectively.

The four-axle steam cars, excluding the narrow-gauge cars, contain 55 (cars MCCi of the Bavarian State Railway) or 66 seats (cars, series 85 and 86, of the Italian State Railway); the accumulator cars contain 66 (Belgian State Railway) or 80 (Saxon State Railway).

The comparison of the total weight, in working order, of automotor cars belonging to each of the different types, with the theoretical weight of ordinary stock, of equal capacity as regards number of seats and space available for luggage and mails, would have presented some interest. But the data we have received in this connection are incomplete, and moreover, there is an inevitable uncertainty in determining the theoretical tare corresponding to the standing-room and to the luggage and mail compartments, owing to the variable utilization of the latter. This comparison is, moreover, implicitly included in the more general comparison of the relative cost of automotor-car services and locomotive services, and so we need not discuss it separately and in detail.

Brake gear. — Hand brakes are fitted to all the automotor cars we are considering, and the brake acts on all the wheels of the two-axle automotor cars.

In the case of the cars with a separate motor truck, the hand brake operated from the driver's cab acts generally on the wheels of the truck; the other wheels are braked from the back platform or from the guard's compartment.

The continuous brake (compressed air or vacuum) is fitted to all the automotor cars except the following: the Ganz steam car and the accumulator car of the Bavarian State Railway; the accumulator car and the Daimler car of the Saxon State Railway; the four Daimler cars of the Wurtemberg State Railway; the Serpollet steam car and the Daimler car of the Austrian State Railway; the Daimler car of the Swiss Federal Railway.

Heating and lighting. — The steam cars about which we have received information, are all equipped with steam-heating apparatus, except the old Belpaire cars of the Belgian State Railway which have stoves for burning coal.

The petrol cars utilize the hot water obtained by cooling the motor, for heating the passenger compartments.

The accumulator cars have stoves for burning coal.

The large majority of the automotor cars we are considering, whether steam or petrol, utilize ordinary oil or paraffin lamps for lighting.

Acetylene is however used for lighting the inside of the following: two Ganz

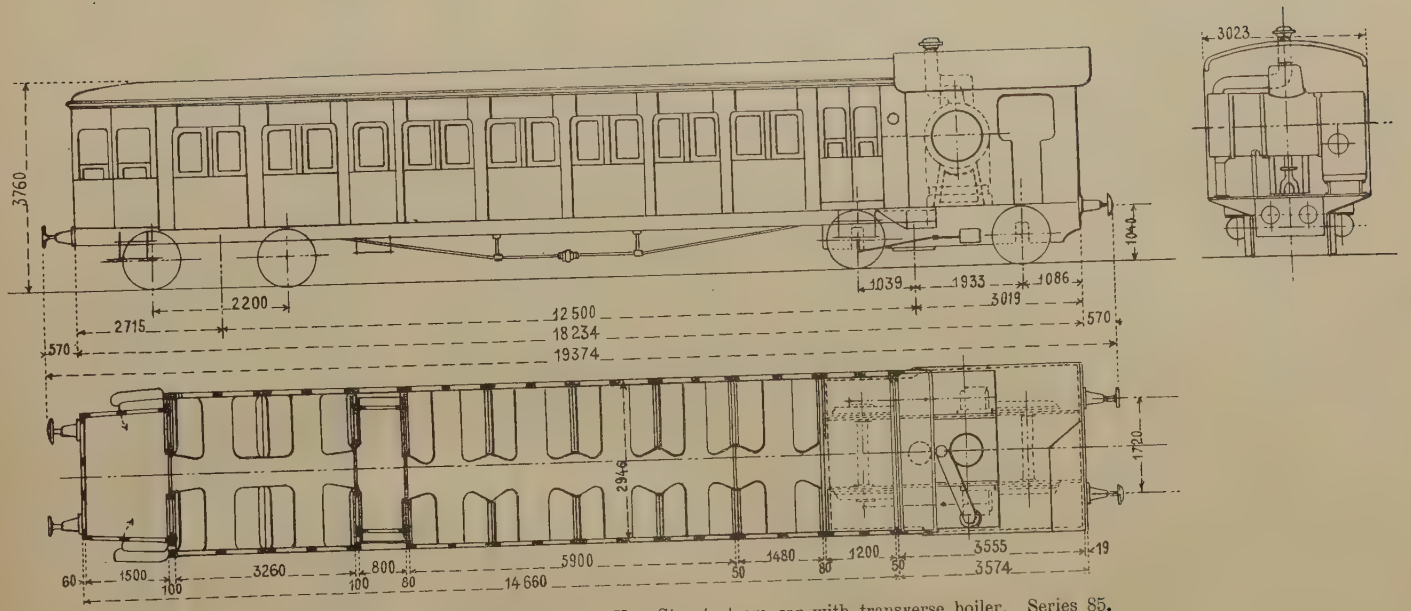


Fig. 5. — Italian State Railway. — Kerr-Stuart steam car with transverse boiler. Series 85.

steam cars of the Austrian Southern Railway; two Purrey cars of the French State Railway; the steam cars series 85 and 86 of the Italian State Railway.

Electric lighting is generally used in the accumulator cars, as well as on the three Purrey steam cars of the Italian State Railway; a battery is provided for the purpose.

Draft gear and buffing gear. — All the automotor cars considered are fitted with draft and buffing gear of the ordinary type, so that they can be coupled up with ordinary stock; the only exception is the one petrol car of the Swiss Federal Railway, which is intended to run always alone, and is not fitted with any draft or buffing gear.

We must also mention the benzo-electric cars, of the Weitzer type, of the Arad-Csanàd Railway, referred to above in connection with a trial run on a line of the Italian State Railway; these cars, although intended to run on standard-gauge lines, are fitted with central draft and buffing gear, being devised to run either alone or with special trailers.

Boilers of steam cars. — The standard type of locomotive boiler, with smoke tubes and a horizontal barrel, is used : on some of the four-axle cars (series MCC*i*) of the Bavarian State Railway; on the two series of the old Belpaire cars of the Belgian State Railway; and on the four-axle cars (series 85 and 86) of the Italian State Railway. The centre line of the boiler is on the longitudinal axis of the car and placed in the normal position, with the chimney in front, on the seventeen Belpaire cars of the Belgian State Railway and on the twelve cars of series 86, Kerr-Stuart type, of the Italian State Railway (fig. 4). On both of them the fire-door is on one side of the fire-box, instead of being in the back wall, so as to make it easier to attend to the fire in a space which is necessarily limited, and to make it easier for the driver, when only one man drives the engine, to see the track and the signals.

On the automotor cars, series MCCi (fig. 3) of the Bavarian State Railway, the boiler is in a longitudinal position, but the chimney is at the back; the fire is fed by means of a charging-cone which acts semi-automatically.

The three automotor cars, series 85 (fig. 5) of the Italian State Railway, have cross-boilers occupying the whole width of the cab on the motor truck. These motor trucks were designed and built by Messrs. Kerr-Stuart & Co., of London; this arrangement has the disadvantage, if used on lines with sharp curves, of altering the level of the water in the crown of the fire-box. The Italian State Railway has consequently decided on placing the boiler longitudinally, when repairs are being carried out; and this has already been done in the case of one of these cars.

Vertical boilers with smoke tubes are used on the Wurtemberg State Railway for the two-axle standard-gauge cars, series DW 5-14 (fig. 6) and for the two-bogie narrow-gauge car DWss 1; also, on the Italian State Railway, for the motor luggage-vans, series 60 (fig. 1).

The Wurtemberg State Railway uses for the above-mentioned cars boilers of the Kittel type (fig. 9); this boiler has its barrel enlarged at the upper part, like the

well-known vertical boilers of the automotor cars of the Great Western Railway. This enlargement is not only intended to give greater water-space and steam-space, but also to reduce the changes in the water-level. The fire-box is cylindrical, made of Fox corrugated plate; the two tube-plates are also treated similarly and connected by 330 tubes; 298 of these are ordinary tubes having a diameter of 24 to 28 millimetres ($^{15}/_{16}$ to 1 $^{3}/_{32}$ inches) 26 act as stays (diameter, 21 to 27 millimetres [$^{13}/_{16}$ to 1 $^{1}/_{16}$ inches]) and 6 are placed at the outer side of the set of tubes; the latter have a larger diameter (40 to 45 millimetres [1 $^{9}/_{16}$ to 1 $^{25}/_{32}$ inches]), in order to facilitate the access of the hot gases to the tubular superheater placed in the smoke box.

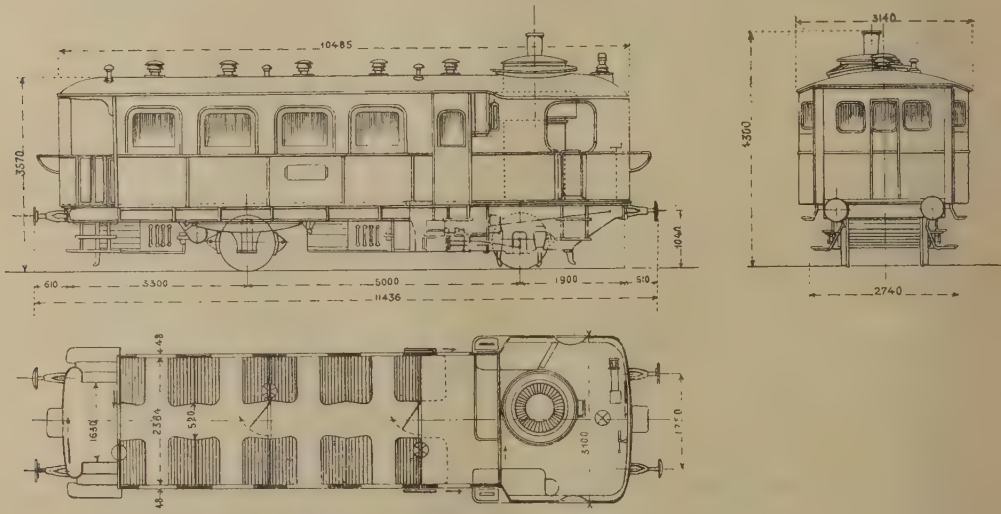


Fig. 6. — Wurtemberg State Railway. — Kittel steam car with vertical boiler.

The motor luggage-vans (series 60) of the Italian State Railway, have an ordinary vertical boiler (fig. 10) with fire-box, tubes and upper tube-plate of copper; twelve of these vans form an exception and are equipped with water-tube boilers, on the Komareck system; two others are fitted, experimentally, one with a vertical boiler with the upper part of the barrel enlarged (fig. 11) the other with a horizontal boiler of the locomotive type with tubes 1 metre (3 ft. 3 $^{3}/_{8}$ in.) in length (fig. 12).

The different types of water-tube boilers used on the cars described in the answers to the list of questions are as follows :

a) The Komareck type (fig. 13) with a cylindrical fire-box of the Fox corrugated type. Several concentric sets of curved iron tubes connect the upper flanged plate with the barrel. A superheater is placed in the large central tube leading the hot gases to the chimney. This type is used on the twelve motor luggage-vans of the

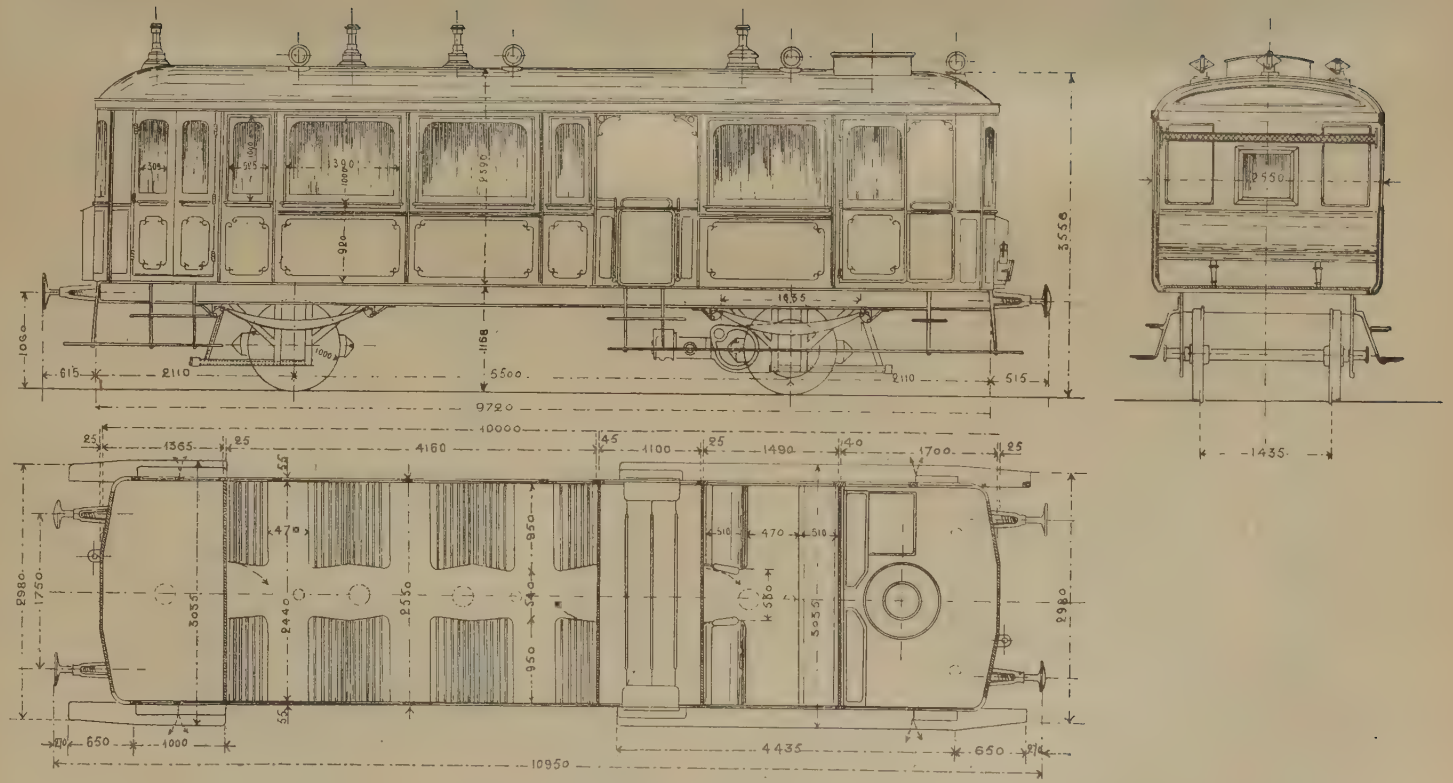


Fig. 7. — Bavarian State Railway. — Ganz steam car.

Italian State Railway, mentioned above, and on three cars of the Austrian State Railway. There are also some used on local railways in Lower Austria and on other secondary railways in Austria (see Mr. Ziffer's report to the Munich Congress, already quoted);

b) The de Dion type, used on the Ganz car of the Bavarian State Railway (fig. 7) and on the two cars of the Austrian Southern Railway. The boiler consists of two cylindrical rings placed one within the other and connected by a large number of very short water tubes, arranged radially and inclined upwards. The fuel is fed into the inside ring and the hot gases flow through the space in which the water tubes are (fig. 14). This is a rapid-steaming type, intended for use on low-powered cars;

c) The type with Field tubes, used on the three four-axle cars of the St. Quentin Railway;

d) The Turgan marine boiler, used on some of the four-axle cars, series MCCi, of the Bavarian State Railway;

e) The well-known Serpollet system, for the sudden formation of steam, with superheat and working at very high pressure (30 kilograms per square centimetre [427 lb. per square inch] and upwards), with very thick tubes, for accumulating heat in the metal; this type is used on four automotor cars of the Wurtemberg State Railway since 1897, on one of the Austrian State Railway and on two of the Paris-Lyons-Mediterranean Railway, which have just been withdrawn from service. The Saxon State Railway and the Swiss Federal Railway each had a Serpollet car in use formerly, now withdrawn from service;

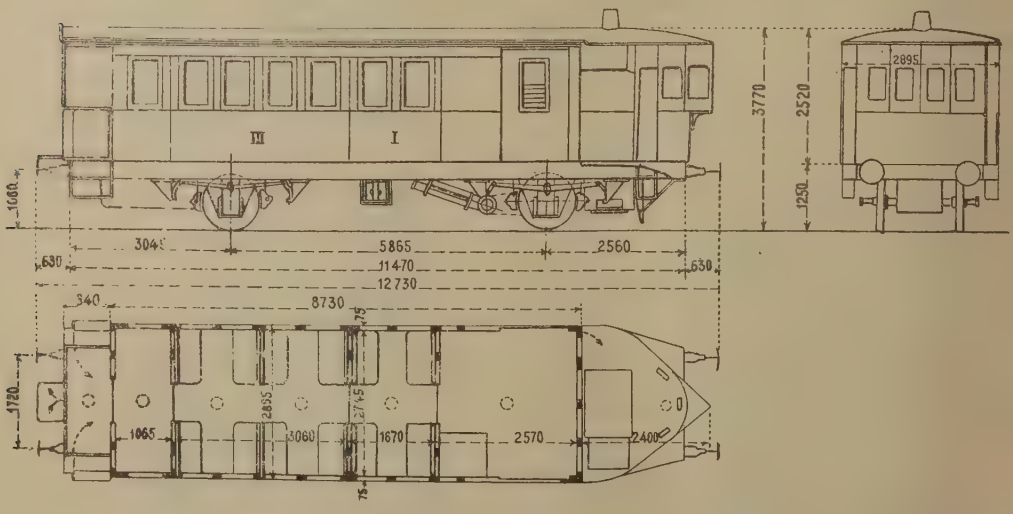


Fig. 8. — Italian State Railway. — Purrey steam car. Series 80.

f) The Purrey system, for the very quick formation of steam, with tubes of little thickness, arranged in coils, and with a steam drum at the top; it resembles the Serpollet type and is equally well known. This boiler is used on three two-axle cars, series 80, of the Italian State Railway (fig. 8), on two two-axle cars of the French State Railway, on eleven three-axle cars of the Orleans Railway, and on eighteen cars of the Paris-Lyons-Mediterranean Railway; six of the latter have two axles and twelve have three axles. They also give superheated steam, at a high pressure (20 to 24 kilograms per square centimetre [284 to 341 lb. per square inch]).

We must also mention the Stolz vertical boiler, used on the Prussian State Railway, which is mentioned in the works quoted, but about which we have received no direct information.

The superheating of the steam, which is inherent in the boiler systems of the Serpollet and Purrey types, is also used, to a limited extent, in the Kittel and Komareck boilers. The locomotive-type boilers of the four-axle cars of the Bavarian State Railway have a Schmidt superheater in the smoke tubes; the Turgan boilers, used on some of the same cars, also have superheater tubes.

Apart from the exceptionally-high pressures obtained in the boilers of the Serpollet and Purrey type, the working pressure in the other boilers varies from 12 to 16 kilograms per square centimetre (170 to 228 lb. per square inch), and reaches 18 kilograms per square centimetre 256 lb. per square inch) in the boilers of the de Dion type used on the Ganz cars.

As regards the dimensions of the grate and of the heating surface, the smallest are those of the de Dion boilers used on the Ganz cars of the Bavarian State Railway and of the Austrian Southern Railway : grate area, 33 square decimetres (3·55 square feet); heating surface, about 8·5 square metres (91·50 square feet).

Next come the Serpollet cars, with a grate area of 46 square decimetres (4·95 square feet) and a heating and superheater surface of 11 to 12 square metres (118·41 to 129·17 square feet).

The Kittel boiler of the Wurtemberg State Railway has a grate area of 51 square decimetres (5·49 square feet), a heating surface of 25·5 square metres (274·49 square feet) and a superheater surface of 9·5 square metres (102·26 square feet).

The Field boiler of the cars of the St. Quentin Railway has similar dimensions; the same can be said of the Komareck boiler of car 1101 of the Austrian State Railway; the other two, series 1001-1002, have a slightly larger grate area.

On all the other steam cars, the graet area varies between 67 square decimetres and 1·08 square metres (between 7·21 square feet and 11·63 square feet); the heating surface varies between 20 and 25 square metres (between 215·29 and 269·10 square feet) on the Belpaire and Purrey boilers, between 39 and 60 square metres (between 419·80 and 645·85 square feet) on the four-axle cars of the Bavarian State Railway and on the Italian State Railway (Turgan and locomotive-type boilers), and on the motor luggage vans of the latter (ordinary vertical boilers, Komareck type, and locomotive-type boilers).

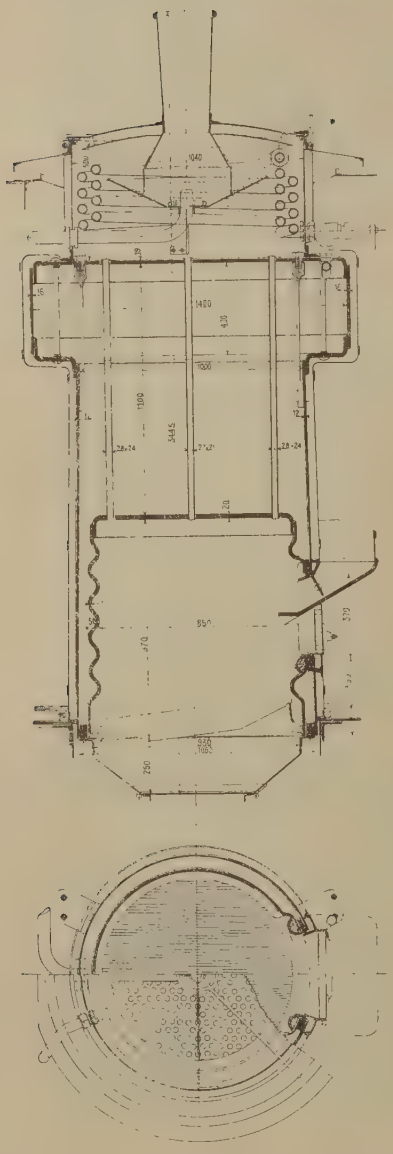


Fig. 9. — Wurtemberg State Railway. — Kittel vertical boiler for car. Serie D. W.

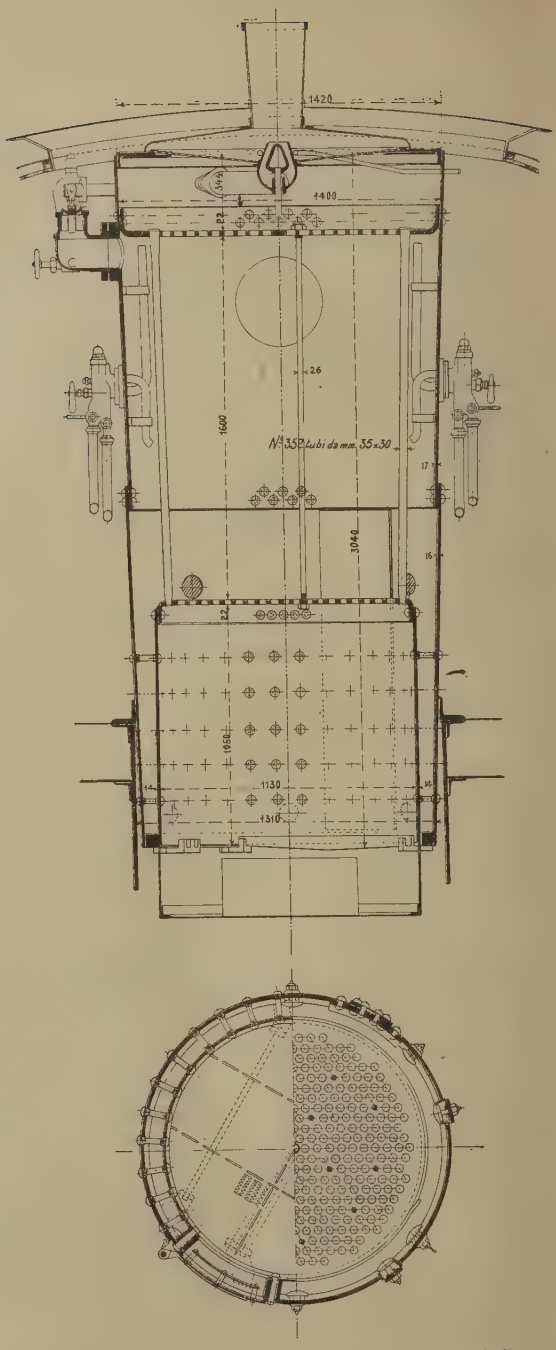


Fig. 10. — Italian State Railway. — Vertical boiler with smoke tubes for motor luggage-vans. Series 60. Original type.

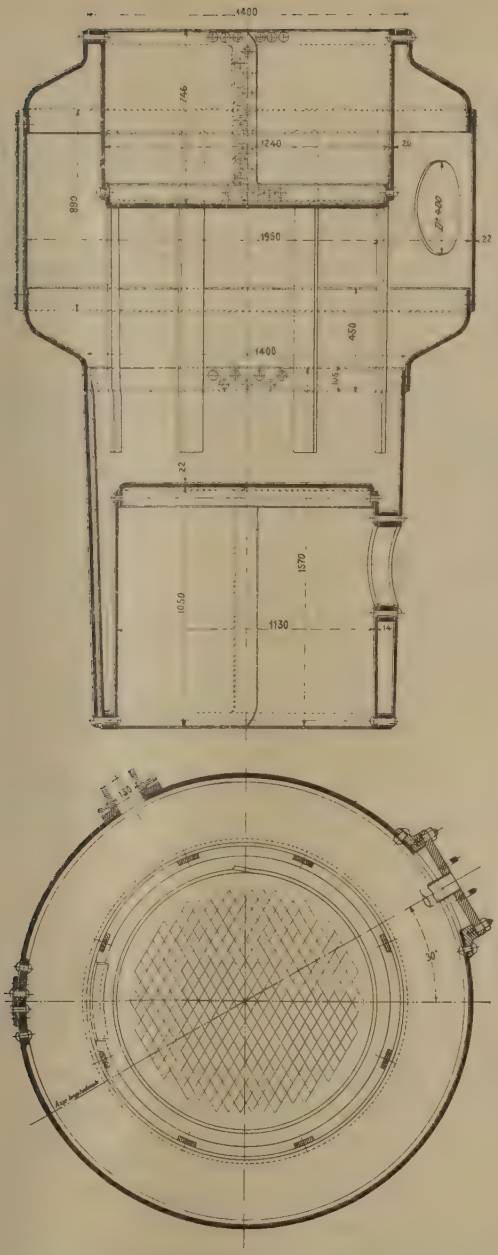


Fig. 11. — Italian State Railway. — Vertical boiler with smoke tubes for motor luggage-vans. Series 60. Modified type (now under trial).

The ratio between the heating surface and the grate area is rather limited in the Belpaire (old Belgian cars), Serpollet and Purrey types. It is included between 23 and 26 with the two former, while it is 24 or 32 with the latter, according to whether the superheater surface is included or not.

In all the other boilers considered, we find ratios similar to those found in locomotives; they are included between 35 and 60, not counting the superheater surface.

The fuel most generally used is still coal. In the case of the cars with de Dion boilers, the Bavarian State Railway always uses coke, while coal is always used on two other cars of the same type, belonging to the Austrian Southern Railway. Coke is exclusively used for the Purrey boilers. On none of the steam cars about which information has been sent to us, is heavy oil used, which is, however, utilized on the small locomotives of the Austrian State Railway (1). Paraffin was used on the Serpollet car of the Paris-Lyons-Mediterranean Railway, which is, however, no longer in use.

The semi-automatic feeding of the grates burning coal reduces the work of firing and makes it

(1) Heavy oil is also utilised on the Stoltz boilers of the Prussian State Railway. (See Guillery, *op. cit.*)

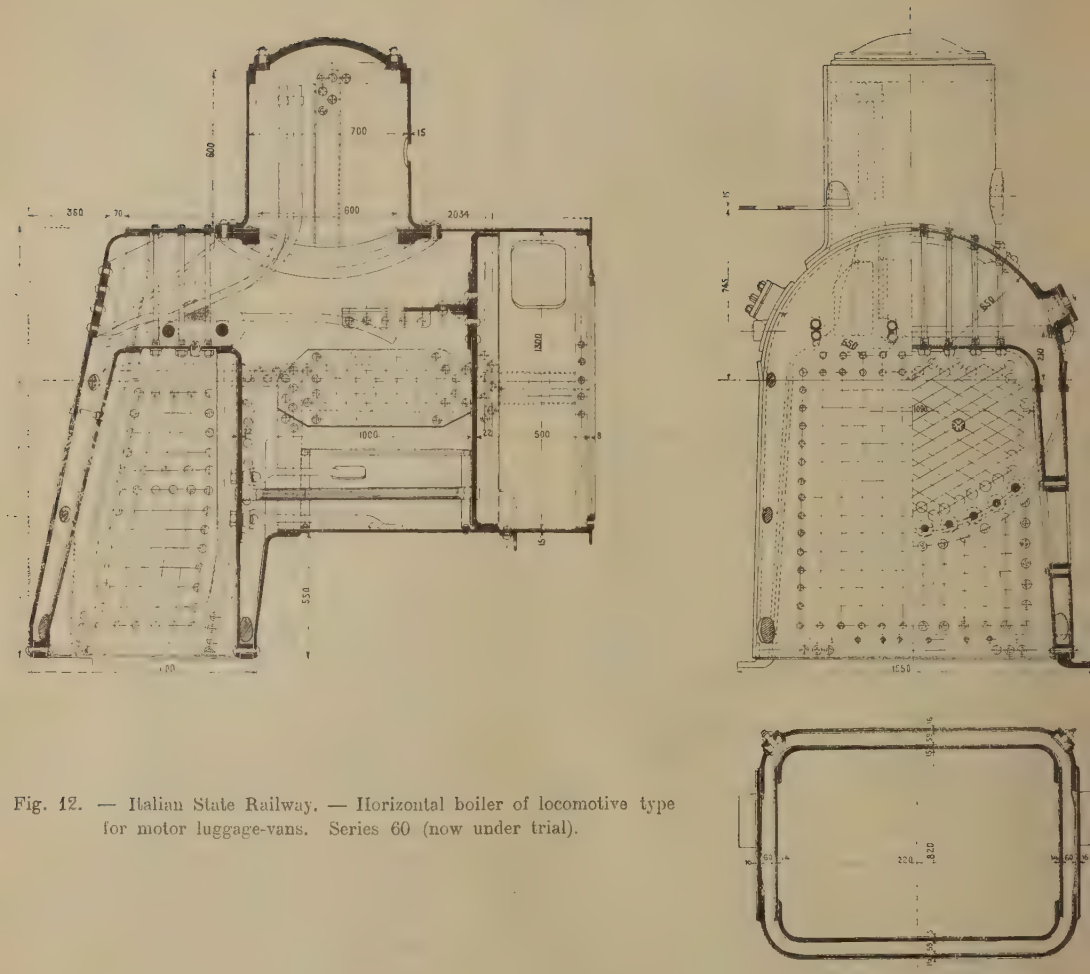


Fig. 12. — Italian State Railway. — Horizontal boiler of locomotive type for motor luggage-vans. Series 60 (now under trial).

easier for one man to run the engine; this is generally applied in the Purrey boilers and also, more recently, in the locomotive-type boilers of the four-axle cars of the Bavarian State Railway.

Feed-water pumps are used for the high-pressure boilers of the Serpollet, Purrey and de Dion types. They only work automatically in the Serpollet system, and partly in the Purrey system. All the other boilers have injectors.

Engine of the steam cars. — Single expansion, with two cylinders, is used in most

cases. The only exceptions are the de Dion motors on the Ganz cars and the motors of Purrey cars, which use double expansion; the former have two cylinders and the latter four. A special arrangement exists in the Bavarian cars with four axles, in which each of the two cylinders incloses two piston heads in juxtaposition, each acting with a separate rod and cross-head on one of the two coupled axles (fig. 3).

Piston valves are used on the four-axle cars of the Bavarian State Railway and on the motor luggage-vans of the Italian State Railway; all the other cars have flat slide valves.

The most usual system of transmission is that of the locomotive type. Spur gearing is used on the Ganz cars, and chain transmission on the Purrey cars. In these cases the gear is protected by a *gear case*.

The power of the steam cars, taken as a whole, varies between a minimum of about 35 horse-power (de Dion motor of the two-axle Ganz cars of the Bavarian State Railway and the Austrian Southern Railway) and a maximum of about 180 to 200 horse-power (four-axle cars of the Bavarian and Italian Railways).

Mechanism of cars with motors of other systems. — The only type of internal-combustion motor used on the cars considered in the answers to the list of questions is, as we have already seen, the Daimler petrol motor, with four cylinders, with a transmission consisting of two or more pairs of gear wheels. It is of 30 horse-power.

We hear that a few builders are at present investigating the application of motors burning heavy oil or petroleum residue direct.

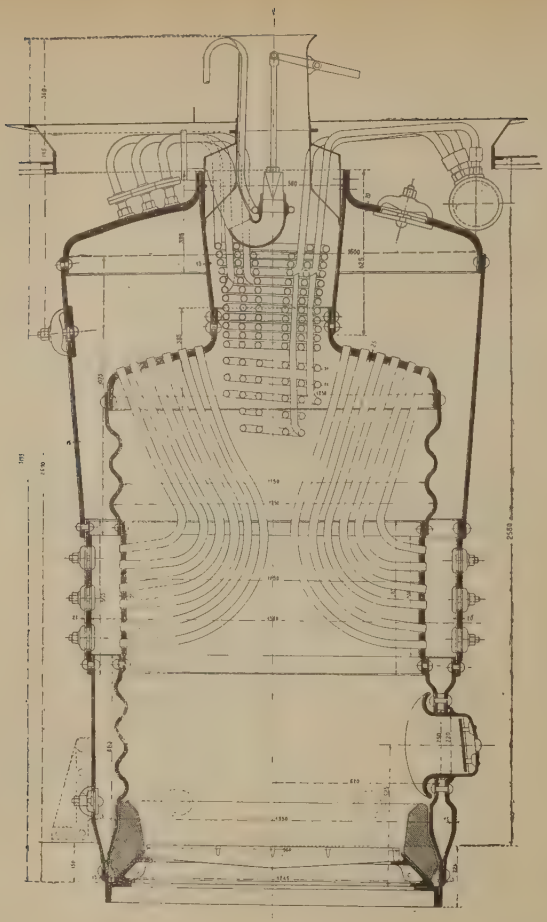
As regards systems with an internal combustion motor and electric transmission (benzo-electric, mixed, etc.) we refer our readers to what has been stated above.

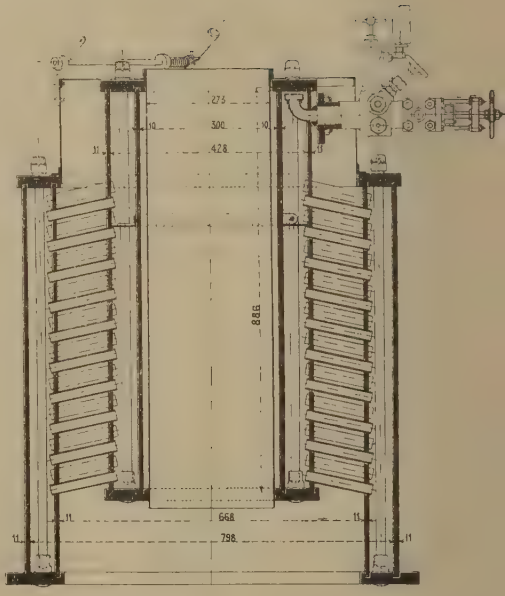
No characteristic peculiarity has to be mentioned in the case of the accumulator cars given in the table in appendix II.

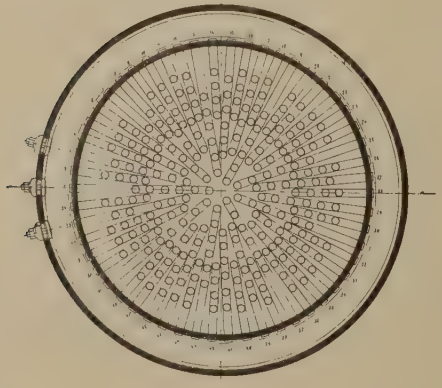
Location of the cab for the driver, provision for travelling backwards. — When considering automotor cars, we encounter the problem of the means of control, as regards the possibility of running in either direction, a problem which is of considerable importance as regards the utilization of the cars.

The most satisfactory solution is evidently that in which perfect symmetry is attained, with identical cabs at each end of the car, each equipped with the same controlling gear. This solution, which makes it unnecessary ever to turn the car, while running in either direction under absolutely the same conditions, is adopted generally in the accumulator cars and in the Daimler petrol cars; but it cannot be attained in the case of steam cars.

There is a fairly considerable number of steam cars, in which the problem of running in either direction has been left out of consideration. These cars only have one cab at the one end, and no means of control at the other end; they must accordingly be turned at the end of every journey. This class includes the old







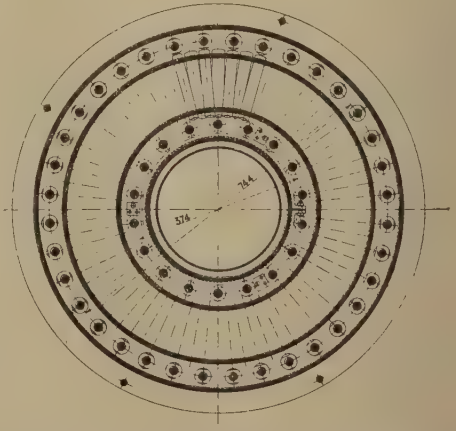


Fig. 13. — Italian State Railway. — Komareck vertical water-tube boiler for motor luggage-vans. Series 60. (now under trial).

Fig. 14. — Austrian Southern Railway. — de Dion-Bouton water-tube boiler for the Ganz car.

Belpaire cars, first pattern, of the Belgian State Railway, and the motor luggage-vans (series 60) of the Italian State Railway, which can be turned on the ordinary station turn-tables, as their wheelbases are short; also the Belpaire cars, second pattern, of the Belgian State Railway, the Serpollet cars of the Paris-Lyons-Mediterranean Railway, the Ganz cars of the Austrian Southern Railway and all the Purrey cars, which having wheelbases which always exceed 5·50 metres (18 feet) require locomotive turntables.

It is however interesting to note the method adopted by the Orleans Railway, which turns the Purrey cars, which have three axles, two forming an independent motor truck, by means of an auxiliary traverser, which can receive the third axle of the car and runs on a circular track concentric with the turn-table which has a diameter of 4·400 metres (14 ft. 5 in.).

The solution sometimes adopted in England, which consists in utilizing a long motor car with the engine in the middle, or else in a small train formed with a small locomotive which is placed between two carriages and has a rather smaller loading gauge than the latter, is not applied by the administrations on the Continent which have sent answers to our list of questions.

All the other automotor cars enumerated in the table, appendix II, are steam cars having a completely-equipped cab at the end where the boiler is, and at the other end an auxiliary cab, or a simple platform equipped with a certain number of controlling apparatus. This post is occupied, when running backwards, by an employee who generally has available a valve for operating the continuous brake, a steam or compressed-air whistle and a lever for closing the regulator. The four-axle cars (series 85 and 86) of the Italian State Railway were at first fitted with a lever which made it possible, by means of a chain, to open or close the regulator; but the opening action has been done away with.

Electric bells or speaking-tubes are generally provided in cars of this kind to enable the driver in charge of the boiler and engine to communicate with the employee on the end platform when the car is running with the engine at the back.

An exception is formed by the small two-axle Serpollet and Kittel cars, of the Wurtemberg State Railway, on which there is no auxiliary post of control at the opposite end to that where the boiler is; there is only a whistle and an extra brake valve. When the car is running backwards, the employee on the leading platform does not intervene except in case of danger, the driving being normally entrusted to the driver, who can see the track and the signals thanks to the limited length of the car and in the case of the Kittel cars thanks to the suitably wider section of thecab.

Use of small locomotives instead of automotor cars. — According to the answers we have received, the Bavarian State Railway and the Austrian State Railway have designed new types of locomotives, in order to operate services of this kind either jointly with automotor cars or in order to replace them.

The Bavarian State Railway at present has in use forty single-expansion locomo-

tives, series PtL $\frac{2}{2}$ particulars of which are given in the table, appendix II; twenty more are being built. These locomotives are of two different types designed and built by the firms Maffei and Krauss respectively.

The boilers are of the locomotive type, with Schmidt superheater in the tubes and semi-automatic feeding of coal, by means of a charging-cone; the boiler of the Maffei locomotives is the same as that used on the four-axle cars of the Bavarian State Railway; the same can be said of the engine, which also has the peculiar arrangement of cylinders each with two pistons working in opposite directions.

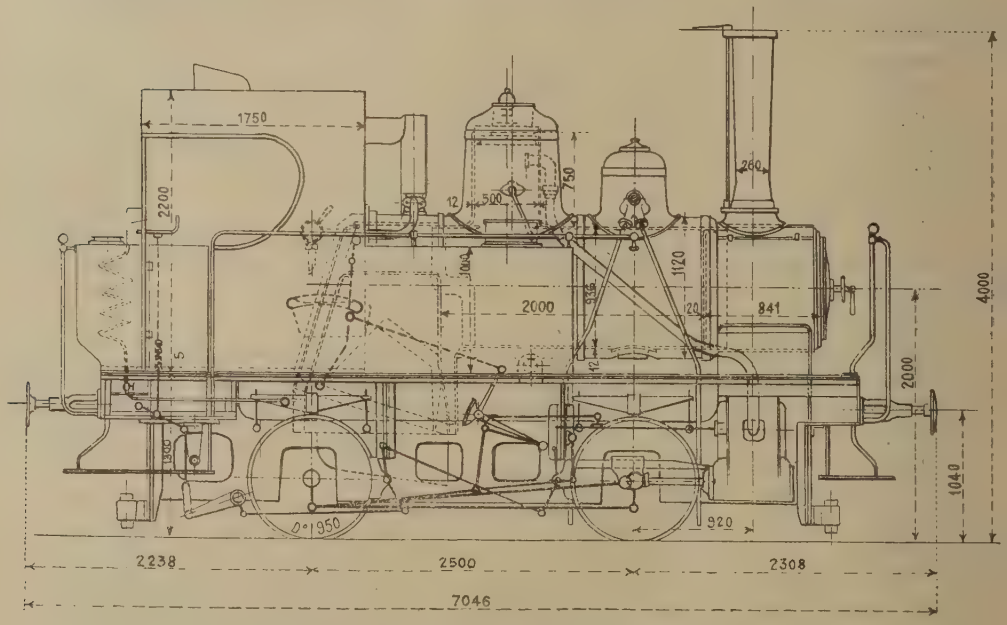


Fig. 15. — Austrian State Railway
Tank locomotive series 86 burning petroleum; the Holden system.

In the locomotives built by the firm Krauss, the connecting rods act on an intermediate shaft which by means of cranks transmits the motion to the coupling rods of the two axles. Particulars are given in Mr. Ziffer's report to the Munich Congress. The weight of these locomotives belonging to the Bavarian State Railway is 18·5 tons (18·2 English tons) empty and about 22·5 tons (22·1 English tons) in working order. The fuel used is coal.

The locomotives of the Austrian State Railway also have two axles (one driving, the other coupled). They belong to two series (185 and 86); the second has a rather more powerful boiler (fig. 15) : the grate area is 65 square decimetres

(7 square feet) and the heating surface 28·7 square metres (308·94 square feet). Petroleum residues are used for firing, the burners being of the Holden type; coal can be used as auxiliary fuel. These locomotives use saturated steam; there are two cylinders and double expansion is used.

The French State Railway has for a long time been using luggage-van locomotives, which are really true tank locomotives with a compartment for luggage and for the guard. They are of two series, both with two coupled axles; they practically only differ in the dimensions of the boiler, and in the number of carrying axles (one or two).

Several of the administrations which use automotor cars also utilize, for similar services, old tank locomotives with two or three axles, weighing 20 to 27 tons, of ordinary construction.

The same applies to some old tank locomotives utilized for local services by three of the administrations which inform us that they are not using any automotors cars: the old French Western Railway, the Norwegian State Railway and the Aussig-Teplitz Railway; particulars of these locomotives are given in the table, appendix II.

II. — **Organization of the service. Modus of working.**

Use of trailers. — The Daimler petrol cars, being of low power, are used exclusively without trailers.

The accumulator cars and the Ganz steam cars of the Bavarian State Railway, and the Serpollet car of the Austrian State Railway, are also generally used without trailers.

All the other automotor cars are used either alone, or, and more generally, with trailers; the maximum number of trailers used is two or three with the Serpollet, Purrey and Ganz cars of the Austrian Southern Railway and attains four to seven with the cars having a more powerful boiler, such as the Belpaire cars of the Belgian State Railway, certain series of the cars with Komareck boiler, the cars (series 85 and 86) and the motor luggage-vans (series 60) of the Italian State Railway.

The luggage-van locomotives of the French State Railway haul light trains, which may include up to sixteen axles.

The continuous brake is used in most cases on the light trains formed of one automotor car with one or more trailers.

Intercommunication between the automotor car and the trailers by means of gangways for the use of the train staff, is only provided on the Wurtemberg State Railway, the French State Railway (only on the light trains hauled by the luggage locomotives) and on the Paris-Lyons-Mediterranean Railway.

The four-axle automotor cars of the Bavarian State Railway are equipped with gangways for such intercommunication, but they are not used.

All the trailers used by the different administrations mentioned are of ordinary type and present no peculiarity.

The Italian State Railway uses either ordinary carriages with two axles, or bogie carriages of a light type and large capacity, specially designed for trains hauled by automotor cars or luggage-van locomotives. A certain number of these carriages are now in use. The typical light train consists of an automotor car (series 85 or 86) with one of these trailing bogie carriages, or of a motor luggage-van (series 60) with two trailing bogie carriages.

No administrations allow automotor cars or small locomotives to push other cars ; this practice is adopted by some of the English companies, in order to avoid shunting operations at the end of a journey.

Maximum speed authorized. — This varies, according to type of car, between 40 and 75 kilometres (25 to 46·6 miles) per hour.

In the case of the Kittel and Serpollet cars of the Wurtemberg State Railway, which are not turning at the end of a journey and which have no auxiliary cab with controlling gear at the opposite end to that where the engine is, this is reduced to 50 kilometres (31 miles) per hour when running backwards.

In the case of the motor luggage-vans (series 60) of the Italian State Railway, which as already stated are normally turned at the end of a journey, it is prescribed that the speed or 18 kilometres (11·2 miles) per hour must not be exceeded in the *exceptional* case of running backwards.

Number of traction agents on automotor cars with or without trailers. — When accumulator cars (even with trailers) or petrol cars are used, the management is entrusted, as a rule, to one driver and to one conductor or guard.

The management is also entrusted to one driver and to one guard in the case of the passenger services operated on the lines which use Serpollet, Purrey and Kittel steam cars, with or without trailers.

The rule of entrusting the management to one single driver, with the eventual intervention of the guard, is not always adopted in the case of steam cars of other types.

Thus the Ganz cars are managed by one single driver and one guard on the Bavarian State Railway, where they always run without trailers, while there are two traction agents, driver and fireman, and one guard on the trains of the Austrian Southern Railway, where the cars always haul two trailers.

The Komareck cars, series 1001-1002, of the Austrian State Railway, which generally run without trailers, and occasionally with one trailer, have two employees on them, driver and guard, while the work is carried out by three men, driver, fireman, and guard on the Komareck car 1101, which is rather more powerful, and belongs to the same railway ; it generally hauls three ordinary carriages.

The four-axle steam cars of the Bavarian State Railway have one or two traction agents, plus the guard, that is two or three men altogether, according to the composition of the train and the conditions of the service.

The old Belpaire cars of the Belgian State Railways had two traction agents.

The ministerial regulations concerning the service of the automotor cars (series 85 and 86) and of the motor luggage-van (series 60) of the Italian State Railway authorize the use of one sole traction agent and one guard under certain conditions. But up till now, the engines have been managed by a driver and a fireman owing to temporary difficulties and service conditions which have made it necessary to use them, in most cases, to haul comparatively heavy trains which should have had locomotives.

In principle, the possibility of having one sole traction agent, which is one of the most important factors in reducing the working expenses of automotor cars, depends on several conditions which it is not always possible to realize fully when using steam engines.

As regards the design of the automotor car, it is above all necessary that the driver should be able to see the track and the signals well, while he must at the same time be able to attend to the boiler and the engine. Every effort must therefore be made to reduce this attention to a minimum, either by the use of semi-automatic stoking gear, or by the use of liquid fuel.

The latter solution, which has been investigated by the administration of the Italian State Railway, at present still encounters difficulties in the case of the small boilers of the locomotive type and of the vertical boilers. A trial of this kind is being carried out on the small locomotives (series 185 and 86) of the Austrian State Railway, as mentioned above.

The semi-automatic feeding of the fire is effected on the Purrey cars (with coke) and on the four-axle cars and the small locomotives of the Bavarian State Railway, having Maffei or Krauss boilers, which burn ordinary coal. Other trials of this kind have been made by other administrations, for instance by the Austrian State Railway on the small locomotives series 85.

The reduction of the traction staff of steam cars to one single driver is also possible, apart from the conditions of the design mentioned above, when the working conditions reduce to a minimum the work the boiler requires, so as to limit the variations of the water-level while running, and to make it possible only to add fuel to the fire during a stop or at long intervals. These conditions occur when very small loads have to be hauled, when the profile of the line is easy, when stops are not far apart, when the journeys are short and when the line, not having too much traffic on it and not being complicated by too many signals, junctions, etc., does not demand too continuous attention from the staff.

When the car, with or without trailers, is managed by one single driver, it is evidently indispensable that the guard or conductor or one of them, it there are several, should be able to stop the car should this become necessary. He must therefore know how to manipulate the controlling gear of the engine, in order to be able to stop the car even if the conti- nuous brake were absent or did not work.

The conditions of design and of service making it possible to reduce the traction

staff to one single man being realized, we will now examine the conditions which have to be satisfied so that a given train, even if there are several trailers, only requires one employee (guard or conductor) in addition to the said driver.

Two cases have to be considered, according to whether the nature of the service or the location of the luggage compartment if there is one, makes it necessary for the guard to be normally on the automotor car, or whether he can pass on to the trailers.

In the first case, it is not necessary to have intercommunication; but then having only one guard makes it necessary to have the continuous brake, as there will be no employee at the tail of the train to attend to matters should a train-break occur.

In the second case, intercommunication is indispensable, to allow the guard to pass from one end of the train to the other, and if necessary to operate the controlling gear of the motor in order to stop the train.

It is evident that when the number of trailers exceeds two or three, it becomes difficult to have only one guard, taking into consideration the requirements of a passenger service; in such cases, it will generally be necessary to have two men, in addition to the driver. The one will be on the automotor car itself while the other will be in the tail of the train.

The same considerations apply in the case of light trains hauled by small locomotives instead of automotor cars.

It would be interesting to examine whether it is better to entrust the head duties, that is to say, the responsibility as regards the ordering of the operations, to the guard or one of the guards, or to the driver. In the latter case, the other employees would be simple guards, only attending to the passenger service, and capable of stopping the automotor car in cases of necessity.

The second system is sometimes adopted in the case of electric traction, whether accumulators be used or current from outside.

In the case of automotor cars with steam or internal-combustion motors, the first of the two systems is generally preferred, consideration being paid to the more extended technical knowledge the driver must have, as well as the considerable work and attention demanded of him; *a fortiori* when the driver must also act as fireman.

Besides it is a question of degree, which can be solved differently according to the local conditions and the qualities of the staff which is available.

Another question of detail, which can also be solved in different ways, is question 4, chapter II, of the list of questions (see appendix I), which refers to automotor cars having the whole steam engine at one end, and an auxiliary look-out with bell, whistle, brake, etc., at the other. When there is only one traction agent, the general practice when the car runs backwards is that the driver remains in his cab and that the front cab is occupied by the conductor.

In the case of two traction agents and one conductor, various solutions are adopted.

On the Komareck car 1101 of the Austrian State Railway, when running backwards, the driver and fireman both stop in the engine cab, and the conductor goes on to the front platform.

With the Belpaire cars of the Belgian State Railway which are normally turned at the end of the journey, the fireman, in the *exceptional* case of running backwards, goes on to the front platform in order to look out at the track and the signals, and the driver remains in his cab.

With the automotor cars (series 85 and 86) of the Italian State Railway, when looked after by three men (driver, fireman and conductor), the fireman remains in the engine cab when running backwards; but the driver goes into the other cab, where he has available appliances for operating the brake and the whistle, and for closing the regulator, as well as a bell system for communicating with the fireman.

As an example, we quote the rules of the Austrian State which have to be observed in order that one single traction agent may be used on automotor cars or small locomotives :

" It is allowed to use small automotor cars and small locomotives managed by one single traction agent when the local circumstances are suitable, and subject to the following conditions :

" *a*) It is forbidden to feed the fire while running if the fire-door is opened;

" *b*) It must be possible to observe from the driver's post both the track and the apparatus which it is necessary to watch while running;

" *c*) There must be a passage leading from the driver's cab, or from the locomotive, to the rest of the train;

" *d*) An employee on the train, apart from the driver, must have the training of a fireman;

" *e*) In each case, the authorization to use one single traction agent is submitted to the decision of a local commission. "

Particulars of the lines operated. — As a rule, the automotor cars are utilized on level lines or on undulating lines with medium gradients of rather limited length.

As regards accumulator cars, we have no information on the subject except as regards the Saxon State Railway, which uses them on the Dresden-Pirna line, which is 17 kilometres (10·5 miles) long and has a maximum gradient of 3 per mil.

The Daimler petrol cars run on lines which have gradients attaining 16·6 per mil, over a length of 2·7 kilometres (1·7 miles) (Pirna-Amsdorf line, Saxon State Railway). There is also a 10 per mil gradient 4·3 kilometres (2·7 miles) long on the Amsdorf-Kamenz line (24·800 kilometres [15·4 miles]).

The Memmingenen-Rossbach line is 53 kilometres (33 miles) in length and has a maximum gradient of 8 per mil.

The chief runs now made *in current practice* by the steam cars of the different administrations are given below in table I.

Table I.

Line		Railway.	Steam car used.	Length of run, in kilometres (in miles).	Steepest and longest gradients.		Maximum distance between stations, in kilometres (in miles).
from	to				Gradient per mil.	Length, in kilometres (in miles).	
Mühlacker. . . .	Backnang . . .	Wurtemberg State Railway	With 2 axles, Kittel type.	50 (31·1)	9	8 (5) about	5 (3·1)
Böblingen	Stuttgart . . .	— — —		20 (12·4)	10	11 (6·8) —	11 (6·8)
. . . . .	. . . . .	Austrian State Railway	Komareck, whit 2 axles	92 (57·2)	18	2·9 (1·8)	7 (4·3)
Alost.	Saint Gilles . .	Belgian State Railway.	Belpaire, 1st pattern, with 3 axles . .	82 (51)	3	...	6 (3·7)
Chartres	Courtelain . . .	French State Railway	Purrey, with 2 axles	54·2 (33·7)	...	...	9.8 (6·1)
Bourges.	Saincaize . . .	Paris-Orleans Railway.	Purrey, with 3 axles	59 (36·7)	6 1·5 to 4	4 (2·5) about 15 (9·3) —	12 (7·5) 8 (5)
Montmorillon. .	Le Blanc . . .	— — —		42 (26·1)	12·5	1·5 (0·95) —	7 (4·3)
Alais.	L'Ardoise . . .	Paris-Lyons-Mediterranean Railway . .	Purrey, with 2 and with 3 axles . .	58 (36·0)	18 to 20 20	6 (3·8) — 3 (1·9) —	6·8 (4·2) 7·7 (4·8)
Bologna.	Rovigo	Italian State Railway	Motor luggage-vans, series 60 . . .	79·2 (49·2)	10	0·8 (0·5)	12·9 (8)
Pisa	Pistoia	— — —		64·2 (39·9)	9·5 to 14	5·3 (3·3)	6·3 (3·9)

N. B. — Certain lengths being taken from small-scale profiles, are only approximate.

Table II.

Railway.	Automotor car used.	Weight in working order, passengers, etc., included, in tons (in English tons).	Number of trailers.			Total weight of trailers, passengers, etc., included, in tons (in English tons).			Total weight of train, automotor car included, in tons (in English tons).			Inclusive speed, in kilometres (in miles) per hour
			Minimum.	Mean.	Maximum.	Minimum.	Mean.	Maximum.	Minimum.	Mean.	Maximum.	
Bavarian State Railway	Steam Ganz type	17 (16·7)	0	0	0	...	...	...	...	17 (16·7)	...	
— — —	Accumulator	31 (30·5)	0	0	0	...	...	...	...	31 (30·5)	...	...
— — —	Steam, with 4 axles	54 (53·1)	2	...	4	44 (43·3)	...	88 (86·6)	98 (96·5)	...	142 (139·8)	
Saxon State Railway	Petrol, Daimler	20 (19·7)	0	0	0	...	...	...	...	20 (19·7)	...	25 to 31 (15·5 to 19·3)
— — —	Accumulator	52 (51·2)	0	...	1	0	...	14 (13·8)	52 (51·2)	...	66 (65·0)	26 to 30 (16·2 to 18·6)
Wurtemberg State Railway	Petrol, Daimler	25 (24·6)	0	0	0	...	...	...	...	25 (24·6)	...	20 (12·4)
— — —	Steam, Serpollet	21 (20·7)	...	...	2	...	...	35 (34·4)	...	...	56 (55·1)	16 to 30 (10 to 18·6)
— — —	Steam, Kittel	24 (23·6)	...	1 to 2	2 to 6	...	...	20 to 90 [1] (19·7 to 88·6)	...	...	44 to 114 (43·3 to 112·2)	
Austrian State Railway	Petrol, Daimler	16 (15·7)	0	0	0	...	...	...	...	16 (15·7)	...	...
— — —	Steam, Serpollet	22 (21·7)	0	0	0	...	...	...	...	22 (21·7)	...	...
— — —	Steam, Komareck	27 (26·5)	0	...	3	...	...	24 (23·6)	27 (26·6)	...	51 (50·2)	...
Austrian Southern Railway	Steam, Ganz	21 (20·7)	0	1	2	...	11	22 (21·7)	21 (20·7)	32 (31·5)	43 (42·3)	22 to 24 (13·7 to 15·0)
Belgian State Railway	Accumulator	...	0	...	2	...	...	...	...	...	...	...
— — —	Belpaire, 1st pattern	20 (19·7)	...	...	7	...	...	80 (78·7)	...	...	100 (98·4)	28 (17·4) about
French State Railway	Steam, Purrey	24 (23·6)	1	...	2	12 (11·8)	...	24 (23·6)	36 (35·4)	...	48 (47·2)	34 (21·1)
Paris-Orleans Railway	Steam, Purrey	29 or 34 (28·5 or 33·5)	0	...	2	...	...	...	...	...	...	32 to 45 (19·9 to 28)
Paris-Lyons-Mediterranean R.	Steam, Purrey (series VAC)	24 (23·6)	0 [2]	...	2	...	...	26 (25·6)	24 (23·6)	...	50 (49·2)	20 to 32
— — — —	Steam, Purrey (series VACF	35 (34·4)	...	...	...	...	20 to 23 (19·7 to 22·6)	22 to 35 (21·7 to 34·4)	...	45 to 58 (44·3 to 57·1)	57 to 70 (56·1 to 68·9)	(12·4 to 19·9
St. Quentin Railway	Steam, Field	24 (23·6)	...	...	2	...	...	10 (9·8)	...	...	34 (33·5)	20 to 22 (12·4 to 19·9)
Swiss Federal Railway	Petrol, Daimler	17 (16·7)	0	0	0	...	...	...	...	17 (16·7)	...	27 to 30 (16·8 to 18·6)
Italian State Railway	Steam, Purrey	26 (25·6)	1	2	3	12 (11·8)	24 (23·6)	36 (35·4)	38 (37·4)	50 (49·2)	62 (61)	35 [3] (21·7)
— — —	Steam, with 4 axles (series 85	46 (45·3)	1	2	4	12 (11·8)	14 (13·8)	45 (44·3)	58 (57·1)	60 (59·1)	91 (89·6)	25 to 37 (15·5 to 23)
— — —	Steam, with 4 axles (series 86)	49 (48·2)	0	3	5	...	18 (17·7)	60 (59·1)	49 (48·2)	67 (65·9)	109 (107·3)	35 to 48 (21·7 to 30)
— — —	Steam, motor luggage-vans	34 (33·5)	2	4	6	24 (23·6)	53 (52·2)	75 (73·8)	58 (57·1)	87 (85·6)	109 (107·3)	23 to 37 (14·3 to 23)

[1] Maximum for the Mühlacker-Backnang line (see table I), 20 tons (19·7 English tons); for the Böblingen-Stuttgart line, 35 tons (34·4 English tons).
[2] On the Alais-Ardoise line (see table I), the automotor cars run without trailers.
[3] At present the service has been stopped, owing to the greatly-increased passenger traffic.

Weight and composition of trains hauled by automotor cars. — The information collected on the subject of the weight hauled, the composition and the inclusive speed of trains hauled by automotor cars, as at present used in current practice, are given in table II.

Daily and yearly mileage of the automotor cars and locomotives, coefficient of utilization. — The Bavarian State Railway, which has eight steam cars, in use from 1904 to 1908, and one accumulator car, dating back to 1901, has not given the average mileage *per day of work*, as the service of these automotor cars is very variable, and not yet definitely organized The average distance run *per year*, *per existing unit*, varies between 12,000 and 20,000 kilometres (7,450 and 12,400 miles).

The Saxon State Railway utilizes the one Daimler car and the accumulator car, built in 1904, for services of 109 and 56 kilometres (67·7 and 34·8 miles) per day respectively. There is no service on holidays. The annual mileage is not given; locomotives act as reserve. The Serpollet car which started working in 1903 was withdrawn in 1906.

The four Daimler cars of the Wurtemberg State Railway were working from 1896 to 1902; two were normally utilized in the service and two served as reserve, in case of repairs, etc. The distance run by the cars in use averaged 224 kilometres (139 miles) per day; there was no service on Sundays; the annual distance run per unit was 33,600 kilometres (20,880 miles).

The four Serpollet cars of the same railway were running from 1897 to 1902; two were used every day and two served as reserve, in case of repairs. The new cars with the Kittel boiler were built 1905-1907; eight or nine are normally in use. The mean annual distance run by each of the Serpollet and Kittel cars is 24,900 kilometres (15,472 miles).

The three Komareck cars of the Austrian State Railway, built 1905-1906, are utilized at three different points of the system, for services of 132, 113 and 153 kilometres (82, 70 and 95 miles) per day. The annual distances run were 29,940, 23,306 and 30,000 kilometres (18,604, 14,482 and 18,640 miles) respectively; the coefficients of utilization are thus 62, 58 and 56 per cent.

The Serpollet and the Daimler car of the same railway are in use since 1902, and are used in one and the same service, in which the distance run is 75 kilometres (46·6 miles) per day of service. The distances run in the year 1907 were 7,893 kilometres (4,905 miles) by the first car and 16,962 kilometres (10,540 miles) by the second car (coefficient of utilization, 29 and 61 per cent).

The two Ganz steam cars of the Austrian Southern Railway are utilized for a service of 90 kilometres (56 miles) per day each. On the average, there are 1·3 units at work, and 0·7 unit under repair; the distance run in the year 1907 was 22,116 kilometres (13,742 miles) per car.

On the Belgian State Railway, the old Belpaire cars, first pattern, were utilized for a service requiring nine units in which the average daily run was 95 kilo-

metres (59 miles) each; the distance run per year was 13,900 kilometres (8,637 miles) per unit.

The French State Railway utilizes its two Purrey cars, built in 1904, for a couple of trains on a total length of 108 kilometres (67·1 miles), there and back; the service is operated by one of the two cars, the other acting as reserve.

On the Orleans Railway, nine of the eleven Purrey cars, built 1902-1905, are in use every day, running an average distance, according to the time-tables (1), of 119 kilometres (73·9 miles) per day. The mean annual distance run is 28,000 kilometres (17,400 miles) per unit, and this represents a coefficient of utilization of 65 per cent.

The average run per day of work of the twenty Serpollet and Purrey cars of the Paris-Lyons-Mediterranean Railway, built 1903-1907, is 108 kilometres (67·1 miles); definite data as to the annual mileage per unit are not yet available.

The three cars with Field boilers used on the St. Quentin Railway, which started in 1907, run 110 to 150 kilometres (68·4 to 93·2 miles) per day, according to season; the average is 43 kilometres (26·7 miles) per day per unit.

The Daimler car started in 1902 by the Swiss Federal Railway normally runs twenty-five days per month, running 92 kilometres (57·2 miles) per day.

The automotor cars of the Italian State Railway, built 1904-1907, are utilized according to time-tables which give an average of 87 kilometres (54·0 miles) per day. The annual mileage per unit has up to the present been limited by the frequent changes made in the programmes of utilization; these changes were in most cases made necessary by the quick and unexpected growth in the number of passengers. At the depots where the service remained more regular, the annual distance run by each unit has varied between 13,000 and 33,000 kilometres (8,080 and 20,500 miles).

The small locomotives which most resemble automotor cars, from the point of view of the services they are designed for, are, as already stated, these of the Bavarian State and the Austrian State railways, built respectively in 1904 and 1903-1905, and the luggage-van locomotives of the French State Railway, which were built in 1885. These run on all the lines of the system. The former are generally utilized on secondary railways, with gradients which attain 25 per mil on a length of about 4 kilometres (2·5 miles) (Bavarian State Railway, branch from Bodenwöhr to Neuenburg).

The annual average mileage of the Bavarian State locomotives amounts to 48,000 kilometres (29,830 miles).

In the case of the two small Austrian locomotives, this figure was 21,500 and 25,200 kilometres (13,360 to 15,660 miles) in 1907, the average distance run per day of work being 110 kilometres (68·4 miles).

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(1) The automotor-car and locomotive time-table of the Belgian, French and Italian railways generally include the days of washing, which accordingly affect the determination of the mean distance run per day, while these are not included in the corresponding time-tables of the other countries.

The luggage-van locomotives of the French State Railway run on the average 25,000 kilometres (15,530 miles) per year.

It must be observed, as far as the Austrian State locomotives are concerned, that owing to their very limited number, it is only the question of a trial, and that the luggage-van locomotives of the French State Railway represent a type which is already old and does not appear very well suited to existing conditions; and this probably explains their limited utilization.

The annual mileage of the forty small Bavarian locomotives is, on the other hand, satisfactory and can be compared with the figures for the ordinary passenger locomotives, while the annual mileage of the automotor cars of all systems is materially lower.

The *coefficient of utilization*, that is to say, the ratio between the number of days of work per year and the total number of days in the year (or else the ratio between the distance actually run per unit per year and the theoretical annual mileage represented by 365 times the daily time-table run), can be estimated at at least 72 to 75 per cent in the case of ordinary locomotives; according to the information collected it is materially lower in the case of automotor cars (29 to 65 per cent).

Information concerning the different methods of utilization from the point of view of working (questions 12 to 16 of chapter II of the list of question). — The use of small train units gives rise to certain problems which do not arise when ordinary locomotives are used.

Thus the runs made by means of automotor cars are considered as made *with a limited number of seats*, and are accordingly marked in a special manner in the time-tables by the following administrations : the Wurtemberg State Railway, the Austrian State Railway, the Orleans Railway and the Swiss Federal Railway. As a general rule, the public is also informed of them, in the time-tables, by the Austrian Southern Railway and the Italian State Railway, but they are not considered as being with a limited number of seats.

The Saxon State Railway formerly indicated in the time-tables what runs were effected by automotor cars, but that is no longer done now. No indication is given in the time-tables of the Bavarian State Railway and of the French State Railway.

The substitution of a locomotive for the automotor car in cases of a sudden rush of passengers is practised by many administrations, for instance the Wurtemberg State and the Austrian State railways, which consider the trains hauled by the automotor cars as trains with a limited number of seats. The French State Railway starts an extra train.

The administration of the Paris-Lyons-Mediterranean Railway distinguishes between three classes of trains hauled by automotor cars; namely, TA 1, TA 2, TA 3.

The trains of the first class are assimilated to the stopping trains, without limitation in the number of seats; they are utilized for carrying parcels and if there is

much traffic a locomotive is used. The two other classes are considered as trains with a limited number of seats; one is utilized for passengers, luggage and dogs, while the other carries passengers only.

As a rule, the automotor cars are used for services either without connections, or connecting with ordinary trains. The Bavarian State Railway alone used them exclusively for local services without connexions.

As regards the programme of utilization, two cases have to be considered : use on main lines and use on secondary lines.

Automotor cars are used on secondary lines by all the administrations considered, except by the Bavarian and the Saxon State railways. The most usual system of utilization consists in runs sandwiched between the ordinary trains hauled by locomotives. On the Austrian State, the Orleans and the Swiss Federal railways, automotor cars are simply utilized in lieu of existing trains carrying but little traffic; while they used for special supplementary runs on the Wurtemberg, the Austrian Southern, the French State and the Paris-Lyons-Mediterranean Railways.

On the Italian State Railway, instances of both systems of utilization are to be found.

The use of automotor cars for the *complete* service of passengers on certain secondary or branch lines is practised on the Belgian State Railway (Belpaire car), the Paris-Lyons-Mediterranean Railway and the Italian State Railway. The small locomotives of the Bavarian State Railway and the luggage-van locomotives of the French State Railway are utilized in the same way. This system of working does not as yet exist on the Orleans Railway, but its application is contemplated.

When the complete service of a secondary line is effected by means of automotor cars, there are always goods trains for slow freight, the parcel and live-animal traffic being carried on the automotor trains, or else by special trains hauled by locomotives if required.

This method of working is not however suitable in the case of a continuous cattle-traffic requiring a number of trucks, too heavy for an automotor car to haul, but not heavy enough to justify the expense of trains specially put on and hauled by locomotives.

The utilization of automotor cars on main lines, in order to improve local communications by *supplementary* runs sandwiched between ordinary passenger trains, is effected by the administrations of the Bavarian State Railway, the Saxon State Railway (which however does not think of extending this application, which is very limited), the Wurtemberg State Railway, the Orleans Railway and the Italian State Railway. In these cases, the automotor cars were not introduced, as in England, in order to compete with tramway lines running parallel to the railways and taking away some of their local traffic; but they were started in order to improve, at a moderate expense, local communications and to give a service at certain stations at which express trains do not stop.

The notion of utilizing automotor cars in order to satisfy certain desires of the

public by instituting cheap and provisional services of an experimental kind, has found no application, according to the information received, except in a few very exceptional cases. On the other hand, it was sometimes found necessary on the Orleans Railway, and rather frequently on the Italian State Railway, to replace automotor cars by locomotives, the rush of passengers to the supplementary trains having increased beyond what was expected.

In Germany automotor cars are rather frequently replaced by locomotives on holidays, either because there is a rush of passengers, or in order to give the employees a rest and clean the cars and attend to their upkeep. Certain runs, on which work men or school pupils are carried, are not made on Sundays.

Stabling of automotor cars. — The automotor cars are everywhere housed in the locomotive sheds, except at some places, where the absence of such installations has made it necessary to put up a simple shed; the accumulator car of the Saxon State Railway stops during the night in Dresden station. The automotor cars are repaired at the locomotive or the wagon shops, according to the class of work required.

The staff operating the automotor cars and looking after their upkeep is always the same as that utilized for the locomotives; some administrations however try to specialize it as much as possible.

III. — Technical and economical results.

Distance run without taking in supplies. — From the point of view of the utilization of automotor cars, given the nature of the service to be carried out, the distance which can be run without taking in supplies is an important factor; but difficulties of a constructive order generally impose a rather short limit to this distance in the case of steam cars and of accumulator cars. Another unfavourable condition is the small efficiency of the boilers and steam engines used, which leads to rather high consumptions.

The steam cars about which we have received information can run a distance of from 150 to 250 kilometres (93 to 155 miles) (according to type, load hauled and profile of the line) without taking in supplies. They can run from 20 to 55 kilometres (12·4 to 34 miles) without taking in water.

The distance which can be run without recharging the batteries is 30 to 40 kilometres (18·6 to 25 miles) in the case of the Bavarian accumulator cars, to 90 kilometres (56 miles) in that of the Saxon State cars, and 100 to 150 kilometres (62 to 93 miles) in that of the Belgian State cars.

The petrol cars are in this respect specially favoured, because for an equal weight of supplies, they can run much further than other cars (the distance amounts to 280 kilometres [174 miles] in the case of the Daimler cars), and the supplies of petrol can be taken, while stopping, very quickly and easily.

In the case of steam cars having boilers heated with coal, the maximum run that can be made without stop is limited, moreover, by the state of the fire, after running about a hundred kilometres (62 miles), even under the most favourable conditions; while cars of other systems are not limited in this respect.

The steam cars are generally supplied with water by the same appliances as are used for the locomotives. In some cases however the construction of the car makes it necessary to put up special water-cranes.

Tractive power, speed. — The most characteristic information we have received concerning the busiest services, is as follows :

The Ganz steam cars of the Bavarian State Railway and of the Austrian Southern Railway attain the speed of 60 kilometres (37·3 miles) per hour on the flat, without trailers, and of 35 to 40 kilometres (21·7 to 25 miles) per hour with one or two trailers (12 to 25 tons [11·8 to 24·6 English tons]). On long ascending gradients of 10 per mil the speed was 25 to 30 kilometres (15·5 to 18·6 miles) per hour without trailers and 20 kilometres (12·4 miles) per hour with one trailer.

The Serpollet car of the Austrian State Railway runs at 40 kilometres (24·8 miles) per hour on the flat, and at 18 kilometres (11·2 miles) per hour on an ascending gradient of 14 per mil; it runs as a rule without trailers.

The Komareck cars (series 1001-1002) of the Austrian State Railway attain a maximum speed of 50 kilometres (31 miles) per hour, and series 1001 attains 60 kilometres (37·3 miles) per hour; on an uphill gradient of 22 per mil they haul 20 tons (19·7 English tons) at 18 kilometres (11·2 miles) per hour.

In the case of the Purrey cars with two axles, the administration of the Italian State Railway finds that 80 horse-power are given normally, and 100 horse-power exceptionally, when hauling one and two trailers respectively, at speeds of 30 to 35 kilometres (18·6 to 21·7 miles) per hour, up long ascending gradients of 15 per mil.

The Purrey cars with three axles on the Orleans Railway attain the very remarkable inclusive speed of 67 kilometres (41·6 miles) per hour normally; and as they often make up lost time they attain 80 kilometres (49·7 miles) per hour on the flat.

The Wurtemberg State Railway states that the Serpollet cars run at a speed of 40 kilometres (24·8 miles) per hour on the flat and at a speed of 15 kilometres (9·3 miles) per hour on an ascending gradient of 10 per mil with a trailer; the maximum speed without trailer is 60 kilometres (37·3 miles) per hour. The cars with Kittel boiler, belonging to the same railway, attain the same maximum speeds and give about 80 horse-power, which corresponds to a load of 30 tons (29·5 English tons) hauled on the flat at the speed of 55 kilometres (34·2 miles) per hour and up a 10 per mil gradient at the speed of 25 kilometres (15·5 miles) per hour.

The four-axle steam cars of the Bavarian State Railway usually run at 75 kilometres (46·6 miles) per hour on the flat, even when hauling 40 tons (39·4 English tons). Up gradients of 10 per mil, they attain speeds of 55 to 60 kilometres (34·2 to

37·3 miles) per hour without trailers, and of 40 kilometres (24·8 miles) per hour when hauling 40 tons (39·4 English tons). The power developed is about 160 to 200 horsepower.

The four-axle cars of the Italian State Railway haul on the flat 45 to 60 tons (44·3 to 59 English tons) at 50 kilometres (31 miles) per hour, and up 15 per mil gradients they haul 20 to 30 tons (19·7 to 29·5 English tons) at 30 kilometres (18·6 miles) per hour; the maximum speed authorized is 60 kilometres (37·3 miles) per hour, but 70 kilometres (43·5 miles) per hour are easily attained.

The motor luggage-vans, whose maximum authorized speed is also 60 kilometres (30·7 miles) per hour, can haul 30 tons (29·5 English tons) up gradients of 18 per mil at 30 kilometres (18·6 miles) per hour, or 40 tons (39·4 English tons) up gradients of 10 per mil at 40 kilometres (24 8 miles) per hour.

The Daimler petrol cars run at the maximum speed of 40 kilometres (24·8 miles) per hour on the flat, of 20 kilometres (12·4 miles) per hour up 10 per mil gradients, of 14 to 18 kilometres (8·7 to 11·2 miles) per hour up gradients of up to 16·7 per mil; in all cases without trailers.

Remarks concerning the regularity and the flexibility of service. — The administrations who have used or tried automotor cars of small size and very limited power complain particularly of the want of flexibility of these cars with regard to the needs of the service. The administrations of the Saxon State Railway and the Swiss Federal Railway both express this view. Similar opinions have been expressed by the Wurtemberg State Railway as regards its Daimler and Serpollet cars only, the Paris-Lyons-Mediterranean Railway as regards its Serpollet cars, and the Italian State Railway as regards its Purrey cars with two axles. Several of these administrations also remark that there is a certain difficulty in running a service which is perfectly regular.

This want of flexibility is also admitted by those railways which use medium-power cars, for instance the Bavarian State Railway and the French State Railway.

Several administrations remark that the flexibility required for the varying needs of the service is necessarily limited by the limited dimensions of the boilers or engines of the automotor cars, and consequently by the small reserve of energy available. It is however observed that it is possible to obtain fairly regular running, and even to make up for lost time, by leaving a sufficient margin when drawing up the time-tables; in many cases this results in reducing the inclusive speed.

The administration of the Wurtemberg State Railway informs us that its last automotor cars, with Kittel boilers, give satisfactory results when used for local services, and that irregularities in the service are neither important nor more frequent than with the ordinary locomotives. The Paris-Lyons-Mediterranean Railway makes a similar statement about its Purrey cars, particularly as regards the more recent ones with three axles, providing they are not overloaded.

Remarks about maintenance. — The majority of the administrations which use or have used motors or boilers of special type state that the maintenance, in consequence of the special design and the complications of the parts, is more troublesome than in the case of locomotives.

The administration of the Austrian State Railway, however, states that the upkeep of the Komareck boilers, in the district in which the quality of the water is not bad, gives rise to neither special difficulty nor considerable expense. The same information is given by the Italian State Railway, in so far as any conclusion can be drawn from the results obtained with the first boilers of this type, which have only been in use for about one year.

The Purrey cars, which have given some trouble on the French State Railway, give good results on the Orleans Railway and on the Paris-Lyons-Mediterranean Railway, if kept properly cleaned; the same can be said of the cars of the Italian State Railway, which however are not running at the present moment, as they no longer were able to cope with the increased traffic.

According to the administration of the Wurtemberg State Railway, the vertical Kittel boilers, apart from some small leaks at the tube-plates which occurred at the start, and which were caused by the bad quality of the water and by want of care, do not require more upkeep than those of ordinary locomotives.

The vertical boilers of the motor luggage-vans of the Italian State Railway showed more leaks and a more costly upkeep, owing to their somewhat forced utilization in certain services for which they were formerly used. The modified boilers (fig. 11 and 12), which have now been tried a short time, appear to behave better.

The upkeep of horizontal boilers, of the locomotive type, which are used on some of the cars of the Bavarian State, the Belgian State, the French State (luggage-van locomotives) and the Italian State railways, do not call for any special remark as compared with the boilers of ordinary locomotives. It has however been remarked that the greater lightness of the mechanism often means greater care and more costly maintenance being necessary.

In the case of automotor cars having a motor truck separate from the main frame, the Orleans, the Paris-Lyons-Mediterranean and the Italian State railways have one or two spare trucks, so as to facilitate maintenance and reduce the immobilization of the cars. The administration of the Bavarian State Railway also provides for this.

The stabling of the automotor cars in the sheds used for the locomotives does not seem to have given any special trouble or difficulty as regards deterioration of the upholstering and the accessories, and as regards keeping it in a good state of cleanliness.

Frequency of laying up and replacement owing to a rush of passengers. — Locomotives are substituted for the automotor cars regularly every Sunday and holiday on some of the German lines. On the Swiss Federal Railway, this substitution is even regular on market days.

The immobilization of the automotor cars owing to this substitution of locomotives on holidays and market days is stated by the Paris-Lyons-Mediterranean Railway to be *rather frequent;* on the Orleans Railway, this immobilization extends to from 5 to 20 per cent of all the automotor car trains. On the Italian State Railway, the automotor cars and the motor luggage-vans have had to be withdrawn from certain services, in which the periodical increase of the passengers on certain weekdays or at certain seasons made it necessary either to work the motors excessively or to replace them too frequently by locomotives. This inconvenience is however considerably reduced by organizing the services so that the automotor cars and motor luggage-vans are only used in the cases they suit best.

It would have been desirable to give more complete particulars regarding the average frequency of the immobilizations of automotor cars in the ordinary service, but we have not received more detailed information.

Reduction in the number of classes. — One measure which may be considered peculiarly effective in facilitating the formation of small train units while making it possible to carry a fairly considerable number of passengers, is the adoption of one single class for services of an entirely local character.

This system has been largely applied by the administration of the Wurtemberg State Railway, which finds it very satisfactory from the point of view of the simplification of the service.

The reduction from three to two classes has been adopted by most of the administrations who have local trains hauled by automotor cars.

Influence of the automotor-car journeys intercalated on the regularity of running of the other trains. — On lines and at stations with much traffic where the number of trains has been considerably increased by intercalating automotor-car journeys between the existing trains, it was to be feared that certain inconveniences might arise in connexion with the occupation of the stations on the regularity of running of the trains. The administration of the Saxon State Railway at first suffered from such inconveniences, but they have been reduced since. All the other administrations answered this question in the negative.

Consumption of fuel. — The data received, which bear a relation to the weight and the speed of the trains, particulars of which are given in the preceding table, are given in table III below.

Cost per kilometre. — The information received on this point is very limited, as was to be expected, considering the experimental character of the use of the automotor cars on some of the railways where the cars at present used are of recent construction and where the programme of their utilization has not yet been definitely settled.

Table III.

Railway.	Type of automotor car.	Mean total weight of train, automotor car included (in tons English tons).	Fuel used.	Gross consumption in kilograms per kilometre (in lb. per mile) (lighting up, etc., included).	*Remarks.*
Saxon State Railway.	Petrol, Daimler	20 (19·7)	Petrol, alcohol.	0·580 (2·058) (alcohol) (1)	(1) And in addition 0·725 kilogram (1·601b.) of petrol for lighting up.
Wurtemberg State Railway	—	25 (24·6)	Petrol.	0·330 (1·171)	
Austrian State Railway.	—	16 (15·7)	Petrol.	0·290 (1·032)	
Swiss Federal Railway	—	17 (16·7)	Petrol.	0·321 (1·139)	
Bavarian State Railway.	Steam, Ganz	17 (16·7)	Coke.	3.600 + 0.300 (2) (12·773 + 1·064)	(2) Charcoal.
Austrian Southern Railway	—	32 (31·4)	Coal.	4·530 (16·072) (3)	(3) Calorific power, 5,000 to 6,000 calories (9,000 to 10,800 British thermal units per lb.).
Saxon State Railway.	— Serpollet.	...	Coke.	2·360 (8·373) (4)	(4) And in addition 0·450 kilogram (0·991b.) for lighting up. Withdrawn from service.
Wurtemberg State Railway	—	...	Briquettes.	2·680 (9·508)	
Paris-Lyons-Mediterranean Railway	—	...	Petroleum.	1·200 (4·258) (5)	(5) At present withdrawn from service.
French State Railway	— Purrey, with 2 axles.	(*)	Coke.	5·000 (17·740)	
Paris-Orleans Railway	— — 3 —	...	Coke.	8·600 (30·512) (6)	(6) High speed, see table II.
Paris-Lyons-Mediterranean Railway	— — 2 —	50 (49·2)	Coke.	5·150 (18·272)	
Italian State Railway	— — 2 —	50 (49·2)	Coke.	5·100 (18·094)	
Wurtemberg State Railway	— Kittel	(*)	Coal.	2·680 (9·508)	
Austrian State Railway.	— Komareck	(*)	Coal (7).	8·400 (29·803) (7)	(7) Bohemian coal. Coefficient of evaporation, 4 to 5.
Belgian State Railway	— Belpaire	(*)	Coal (8).	6·500 (23·062)	(8) Semi-fat.
Bavarian State Railway	with 4 axles.	(*)	Coal.	8·000 (28·383) (9) 9·500 (33·705) (10)	(9) Ruhr coal. (10) Bohemian coal.
Italian State Railway	— with 4 axles series 85.	60 (59·1)	Coal.	6·400 (22·707)	
— —	— with 4 axles, series 86	67 (65·9)	Coal.	6·400 (22·707)	
— — —	— motor luggage-van, series 60	87 (85·6)	Coal.	8·400 (29·803)	
	Small locomotives :				
Bavarian State Railway	Steam with 2 axles.	...	Coal.	4·000 to 7·000 (9) (14·192 to 24·836) 5·000 to 8.500 (10) (17·740 to 30·157)	
French State Railway	Steam, luggage-van locomotives	...	Coal.	7·000 (24·836)	

(*) See table II.

The administration of the Bavarian State Railway, not being as yet in a position to determine the cost of staff and upkeep, has only given the cost of the materials used, which is as follows :

—	Ganz cars with two axles.		Cars with four axles.	
	Franc.	(Pence.)	Franc.	(Pence).
Fuel, per kilometre (per mile).	0·144	(2·225)	0·198	(3·059)
Lubricant, per kilometre (per mile)	0·013	(0.201)	0·017	(0.263)
Other materials, per kilometre (per mile)	0·003	(0·046)	0·005	(0·077)
Total for materials, per kilometre (per mile). . .	0·160	(2.472)	0·220	(3.399)

The Austrian Southern Railway gives, for its Ganz cars, a total expenditure (materials, staff, upkeep) of 0·298 franc per kilometre (4·604*d*. per mile), while it estimates at 0·290 franc per kilometre (4·480*d*. per mile) the cost of traction in the case of the tank locomotives used for similar services.

The total cost of traction per kilometre amounts, according to the administration of the Saxon State Railway, to 0·620 franc (9·579*d*. per mile) for the Daimler cars, to 0·550 franc (8·497*d*. per mile) for the Serpollet cars, and to 0·400 franc (6·180*d*. per mile) for the tank locomotives, of suitable type, hauling one carriage.

According to information supplied by the administration of the Wurtemberg State Railway, the same costs per kilometre on this railway amount to :

—	Daimler car.		Steam car, Serpollet and Kittel system.	
	Franc.	(Pence.)	Franc.	(Pence.)
Fuel, per kilometre (per mile)	0·115	(1·777)	0·070	(1·081)
Lubricant, per kilometre (per mile).	0·013	(0·201)	0·004	(0·062)
Traction staff, per kilometre (per mile)	0·057	(0·881)	0·075	(1·159)
Upkeep, per kilometre (per mile)	0·047	(0·726)	0·060	(0·927)
Total. . .	0·232	(3·585)	0·211	(3·260)

The cost of various items (lighting, steaming, water, etc.) is not given.

Finally, the data, per kilometre, deduced from the information supplied by the Austrian State Railway are :

—	Daimler cars.	Serpollet cars.	Komareck cars.	Locomotives, Series 86 and 185.
	Franc. (Pence.)	Franc. (Pence.)	Franc. (Pence.)	Franc. (Pence.)
Fuel, per kilometre (per mile) . . .	0 084 (1·298)	0·062 (0·958)	0·069 (1·066)	0·125 (1·931)
Lubricant, per kilometre (per mile) . .	0·024 (0·371)	0·020 (0·309)	0·019 (0·294)	0·005 (0·077)
Water, per kilometre (per mile). . .	...	0·005 (0.077)	0·005 (0·077)	0·004 (0·062)
Cleaning materials, per kilom. (per mile)	0·005 (0·077)	0·005 (0·077)	0·008 (0·124)	0·007 (0·108)
Traction staff, per kilometre (per mile).	0·109 (1·684)	0·108 (1·669)	0·140 (2·163)	0·177 (2·735)
Upkeep, per kilometre (per mile) . .	0·094 (1·452)	0·109 (1·688)	0·090 (1·390)	0·044 (0 680)
Total. . .	0·316 (4·882)	0·309 (4·774)	0·331 (5·114)	0·362 (5·593)

The figures giving the cost prices are not complete; these however vary within very wide limits, and the prices cannot all be compared.

An interesting deduction can however be drawn from the comparison between the cost prices of automotor cars and of equivalent locomotives *belonging to one and the same administration.*

We have the following particulars available :

Bavarian State Railway. — The steam cars with four axles cost 59,000 francs (£2,360), while the small locomotives cost about 36,000 francs (£1,440).

Austrian State Railway. — The Komareck cars cost 38,000 francs (£1,520) and 54,000 francs (£2,160), according to series, while the small locomotives of the two series cost 23,000 and 29,500 francs (£920 and £1,180).

We see that the difference between the two prices represents the cost price of an ordinary carriage with a capacity similar to that of the autocar.

On the other hand, as we have already seen, the annual mileage of the locomotives can more easily attain high figures.

It follows from this that the cost per kilometre for interest and renewal of the stock does not give less favourable figures in the case of locomotives than in that of automotor cars.

CONCLUSIONS.

Automotor cars, examples of which are already to be found when railways first began (1), were not used, until about 1895, except quite exceptionally and for applications of short duration. Their use has assumed a certain development since, with a view to satisfying, economically, the continually-growing demand for frequent communications, either on secondary lines, or at small stations on main lines.

This resumption of the application of automotor cars has given rise to a considerable number of new types of cars, specially designed with a view to the new requirements, and profiting by the technical progress which has been realized.

A comparatively large number of cars of several of these new types are at present in regular service on different lines on the continent of Europe; others are utilized for services which are still of an experimental character. Nevertheless the administrations who have answered our list of questions agree in informing us that they have at present no automotor car under construction, and do not for the moment foresee any further extension of the automotor-car services.

The economic advantages which may be expected from the use of automotor cars consist essentially in the reduction of the number of employees and in the formation of small train units which represent a reduced capital outlay and consequently reduced charges for interest and renewal; this result is only attained by sacrificing part of the flexibility locomotives usually have.

But this flexibility, on the advantages of which it is unnecessary to dwell, may sometimes become an obstacle to the realization of a very economic service, given that in practice the composition of the train, increased for exceptional requirements, can easily be conserved as normal, although a lower *average* utilization of the seats results.

The necessarily limited power which characterizes automotor cars is, on the contrary, a guarantee that the reduced size fixed for the trains is really adhered to, and this ensures the realization of the economies it was proposed to effect. But these economies cannot be realized except under condition of having traffic which is *nearly always equally* large; for in fact if it was frequently necessary to replace the automotor car by a locomotive, the mean annual utilization of the automotor cars would become very low; and the charges for interest and, in part, for amortization, would be nearly doubled.

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(1) The oldest are the Adams cars, with boiler of locomotive type, used between London and Norwich in 1849, and others, with vertical boiler, which were utilized between Bristol and Exeter. Next came the Fairlie cars, with horizontal boiler, and the Fairlie and Samuel cars, with vertical boilers, in 1868. We next find in Switzerland the Brunner steam omnibus, used on the Lausanne-Echallens line in 1876; and in 1877 the first Belpaire cars on the Belgian State Railway and on the lines of the old railway company of upper Italy. (For further details, see Guillery, *op. cit.*)

It must also be noted that the annual mileage of automotor cars, even under favourable conditions, cannot be compared with that which can be obtained with ordinary carriages. This mileage depends, in fact, on the periods of immobilization resulting from the repairs of the mechanical part. It follows that the immobilization of the carriage part is increased by the fact of its connexion with the motor, and this represents a percentage (for interest and amortization) on the value of the carriage part, higher than in the case of ordinary carriages. This disadvantage can be eliminated by the use of separate motor trucks.

The reduction of the staff required for the service cannot, as mentioned above, be realized under all conditions of the service, of the line, etc., or in the case of all types of automotor cars, chiefly owing to the care required in driving the engine.

The whole of the information received and of the particulars discussed, leads to the following conclusions :

1° Automotor cars can be used in certain cases for economic services, in order to facilitate local communication at a moderate outlay, provided that the traffic conditions lend themselves to the organization of frequent trains, carrying a regular traffic or at least one which only varies rarely and but little, that the line is an easy one and that the goods traffic can be carried conveniently and completely on separate trains;

2° The power of the motors of the automotor cars should present a certain margin beyond the ordinary work, so that it is possible to cope with variations of the traffic within certain ascertained limits;

3° It would be desirable to make it possible to utilize the car independently of the motor by having either separate motor trucks, or some other device making it possible to remove and replace the mechanical part easily.

4° From the point of view of economy of staff, that is to say having only one traction agent, accumulator or petrol cars seem the most suitable. The types used by the administrations who have given us information represent units of too low a power. It would be desirable that investigations should be made in order to increase this power suitably (1), and to ensure easy and inexpensive maintenance.

5° As regards steam cars, it would be desirable to reduce to a minimum the care required for the boiler and in particular to improve the semi-automatic feeding of the grate or to improve the methods of using liquid fuel.

6° It would be desirable to recommend the investigation of small locomotives able to replace automotor cars, with the advantage of greater independence. The luggage-van locomotives, or the motor luggage-vans, represent an intermediate solution, which it seems can be suitably applied in certain cases.

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(1) This line has been adopted on the Prussian State Railway in the case of accumulator cars, and on some of the United States lines, in that of petrol cars.

APPENDIX I.

Detailed list of questions relating to question XII.

N.-B. — *The reporter begs administrations who have no automotor-cars in service at present but who have experimented with them in the past to be kind enough to reply to the questions put, explaining the reasons for having given up the system.*

Similarly he hopes administrations who have motors on order will supply detailed information as regards the pattern selected and the purposes they are designed to serve in operation.

LIST OF QUESTIONS.

I. — Description of railway automotor cars.

A. — What are the various types of automotor-cars, or motor luggage-vans, which you have in use on your Railway?

B. — Will you kindly supply the following data and particulars :

1. Kind of motor :

a) If driven by steam.
b) If by explosion of oil or gas with merely a mechanical transmission of motion.
c) If by explosion with transmission and electric driving gear.
d) If electric with accumulators.

Note. — The interrogatory does not take into account the electric automotors taking their current from outside.

2. Design of the automotor-car (elevation and plan), preferably to the scale of $^3/_4$ inch to 1 foot.

Please also show on plan :

Driving axles;
Coupled axles;
Gauge of track;
Section of rails;
Distances from centre to centre of the axles and of bogies;
Diameters of wheels respectively;
Length over buffers;
Length over body;
Width over body;
Width and the inner height of compartments;
Maximum height from rail.

3. General design, with sections, of the motor, of the boiler (if any), and accessories, preferably to the scale of $^3/_4$ inch to 1 foot.

It would be advisable to have, apart from above, the most characteristic details of construction.

For automotors consisting of an independent engine, or else of an almost independent motor-truck, and of a car fastened to said engine, or else carried on one end by the underframe and on the other end by an axle or an ordinary bogie, please show how the car is joined to the engine.

4. Weight of the automotor when empty.

Weight of the engine alone, where it constitutes a separate underframe.

Weight when at work, with its full outfit (water, fuel, etc.); but without passengers or luggage.

How is said weight apportioned over each pair of wheels.

In the event of the weight per pair of wheels being limited by the state of the line and the bridges you are asked to say :

The maximum weight of the load allowed on the rails.

The weight of the rails per yard.

The length of the rails, and the number of sleepers for each rail.

5. You are also asked to state what would be the approximate weight, when empty, of an ordinary car or luggage-van of your normal type, the most similar from the point of view of comfort, strength, stability, etc., to the automotor-car having the same capacity for passengers and luggage.

6. What are the classes and number of seats available for each class ?

Limit of weight, or maximum capacity of the luggage-compartment; and (if there is one), of the compartment for the mails.

7. Brake-gear : Screw-brakes, lever-brakes, steam brakes, etc., continuous brake (of what system?).

Wanted to know, for each brake gear if it acts on all the wheels on the automotor-cars, or on part of them only.

8. System of heating.

System of lighting : for the car; for the driver's cab, for the outside lamps, at front and at tail end.

9. Is the automotor-car provided with buffing gear of the normal type of your railway system, or have you adopted gear of a special type in view of an exclusive service with or without trailing cars specially built? In the second case you are asked to supply a sketch.

10. For motor-cars or motor luggage-vans *with steam motors* you are asked to state :

a) the type of boiler, with particulars of details for the special systems;

b) the grate area; the number, length, and inner diameter of the tubes; the heating surface of the fire-box; the heating surface of the tubes, of the tube plates, of the fire-box plates (*for boilers of locomotive type, and for vertical boilers with smoke tubes*).

Corresponding data for water-tube boilers or special types.

If making use of super-heating apparatus you are asked to give separately the value of the heating surface for the production of saturated steam, and of the surface of super-heating and to give the average and maximum temperature of the super-heated steam.

c) The number and type of feeding apparatus (injectors or pumps), of safety valves, blower; sizes and system of blast pipe (fixed or variable?);

d) normal pressure;

e) the kind of coal used : lumps, patent fuel, small, or coke.

In case of making use of a charging cone for the mechanical and continuous feeding of the fire-box, please give details;

in case of using liquid fuel, you are asked to send the scheme of the combustion apparatus, and to name the kind of liquid fuel used : rough mineral oils, residues of distillation, or other matters.

*

Kindly say :

1° if the liquid fuel is used exclusively during the journey or mixed in combustion with coal or coke;

2° if, in the latter case, you use exclusively at times, the liquid fuel, or the coal, according to the changes in the cost price of the two qualities of the above-mentioned fuels.

f) the data relating to the mechanism; simple or double expansion? Number of cylinders, diameter, length of stroke, type of distributors; system of distribution, return of transmission in case where a chain, or a cog-wheel gearing return is made use of, etc., particulars of the details of the motion and of the construction of the details, lubrication etc., which may offer particular interest.

11. When explosion automotors are made use of, either with electrical driving-gear or accumulator electric system, kindly send detailed description of the system, with characteristics of the automotor and the data relating to the methods of transmission.

12. Location of the cab or cabs, for the driver. Is there one cab only at one of the ends? with what arrangement for travelling backwards, if such is allowed? or are there two similar cabs with identical or other outfit, one at each end?

For automotor-cars having at one end a complete engine, and at the other an auxiliary cab occupied by an acting motorman during the travelling backwards kindly give the outfit of the auxiliary cab, and the means of intercommunication with the cab of the engine; of electric ringing, whistle (steam or compressed air); of working of the regulator (closed only, or closed and open?); of the working of the continuous brake; of the screw brake (acting on all the wheels of the automotor-car); etc.

13. Have you thought of adopting for the local trains or light trains, small locomotives specially designed in view of a very economical service, instead of the automotor-cars?

In the affirmative, kindly forward the scheme, the data characteristic of the boiler and the mechanism, the weight when empty, the full weight when at work and its load per pair of wheels.

14. If you have no small locomotives specially designed for services similar to those which are worked by your automotor-cars, please send the particulars asked for in question No. 13, for passenger locomotive-tenders of the lightest type you have in service.

II. — Organization of the service. Mode of working.

1. For each of your types of motor-cars, you are asked to state if you employ them exclusively isolated, or with trailing cars.

In the second case, is there intercommunication between the automotor-car and the car following, and between one and the other of the trailing cars?

Do you make use exclusively of the plant with continuous brake or not?

2. Please say for each of your automotor-car types (including the automotor luggage-vans, postal wagons, motors, etc., if the handling is entrusted to two traction agents or to only one.

Show the number of working agents whom you employ, over and above the said traction agents :

a) for the automotor-cars working alone,

b) for the automotor-car towing one or several cars.

In the second case, does the number of agents depend on the number of cars, on the declivities of the line, on the existence or otherwise of passages for intercommunication, on the working or otherwise of the brake?

3. For automotor-cars that have one single cab for the driver or motorman at only one end, you are asked to say if, at the end of the journey you always turn the automotor-car on the turntable.

In the contrary case, what is the maximum speed which you allow when the automotor-car travels with the driver's cab at the trailing and leading ends respectively.

In view of avoiding shunting at the end of the journey, for the local to and fro services, do you allow the circulation of automotor-cars pushing one or several cars. What is, in this case, the maximum speed allowed?

If more than one car is attached to the motor-car do you push any in front; if so how many do you allow, or do you always attach the additional cars on behind so as to draw them.

4. For the automotor-cars having a complete engine at one end and an auxiliary cab with ringing, whistle, brake, etc., at the other end, and handled by one motorman and one assistant motorman (driver and stoker), does the driver, in the case of travelling backwards, ake his post at the front, that is to say, in the auxiliary cab, and does the stoker remain in the engine cab, or *vice versa?*

If, on the contrary, you employ for these automotor-cars only one motorman, does the said man, while travelling backwards remain in the engine cab, the cab at the front end being occupied by the train guard or by a brakesman duly authorised?

5. In the case of small locomotives, referred to in question 1-13, have you adopted the system of entrusting the handling to one man only?

Do you use continuous brakes upon the motor-cars and also where they haul trailer-cars, and have you intercommunication with the first car hauled or all cars hauled or pushed.

Do you use liquid fuel or any arrangement for the continuous automatic feeding of the grate with coal?

6. Please supply profile of the lines or sections of lines worked by the automotor-cars, showing the distances between the stations, the differences in altitude, the maximum gradient and their length, the longest gradients and their development, the minimum radius of the curves.

7. Enumerate the services daily performed on your system by the automotor-cars, showing the types of automotor-cars respectively used, the stations at the extreme ends and mileage corresponding to each run, the total running per day for each of your types of your automotor-cars and the general total.

Are any of those services divided into two stages, worked by two different automotor-cars, on account of the length of the journey? Please also give the maximum daily working for automotor-cars of your various types; or better still give if possible, the rotation of the automotor-cars in a graphic form.

8. Average weight when empty and when at work, number of seats available for each class; number of axles of the cars usually hauled or pushed by the automotor-cars.

9. For every one of the journeys worked by your automotor-cars (See No. 7), kindly show :

a) The average and maximum number of the hauling cars and the total weight corresponding thereto (inclusive of travellers, luggage, etc.)

b) The time-table, showing stoppages, and times of departure and arrival.

10. For each type of automotor-cars on your system, you are asked to state : the number actually in existence; the date of building the oldest and the last; the number of units effectively employed in the daily service; the average number of units stopped for washings, repairs, eventual substitutions; the annual mileage run per motor-car.

11. For the small locomotives referred to in question I-13, if you have such, you are asked to reply to question 6 to 10, as above, inasmuch as this may be of interest, with regard to comparison with the automotor-cars.

12. As regards the conditions for carrying passengers, do you inform the public what are the runs provided for by the time-table, and worked by means of automotor-cars?

Are they considered as trains with a *limited number of seats?*

In the contrary case, if there comes about an extraordinary rush of passengers, do you start a supplementary train, hauled either by another automotor-car or by a locomotive, or do you merely start a locomotive with a larger number of cars instead of the automotor-cars?

Are the runs provided by automotor-cars, submitted to fixed times with other trains, or have they an exclusive character of local service, independently of any coincidence.

13. Is your programme for the use of automotor-cars for secondary lines limited to various supplementary runs sandwiched between the abready existing trains hauled by the locomotives?

Hase you made use of, or do you think of using the automotor-cars, *for the complete service of passengers* on some branch, or some short line? Have you been obliged, in that case, to create goods trains hauled by the locomotives, whereas previously you had only mixed trains? How have you managed for the carrying of cattle and express goods?

14. Does your working programme include an extended use of automotor-cars on the principal lines? In the affirmative, what would be essentially your purpose? Fight the competition of the tramways, or other means of communications at short distances? Or rather, to improve at a moderate expense, certain communications having a local or outskirt character? Have you perhaps thought of making use of the automotor-cars to create on several sections of the long lines, journeys with stops at all the stations, a little before and directly after the passing of the long-run express trains, for the purpose of improving the communications of the less important centres without increasing the number of stoppages of the express trains?

15. Have you also thought of utilising the automotor-cars, to set up, at a moderate expense, temporary communications by way of trial, in order to ascertain the quantity of passengers, with a view to converting them, after a given time of experiment, and in case of good results, into passenger trains, hauled by locomotives and to suppress them, if otherwise? Have you any instances?

16. Have you preferably allotted automotor-cars to sundry local journeys that do not occur on Sundays and holidays? Do you avail yourself of these interruptions for washing and upkeep, with a view of working the system with a smaller number of reserve automotor-cars?

17. Are your automotor-cars stored and kept up in the same sheds as the locomotives? Or have you organised a service of separate sheds? Are these sheds worked by the same staff which attends to the service of the locomotives, or have you specialised staff?

III. — Technical and economical results.

1. For each of your type of automotor-cars, please say the maximum distances which you can practically run in regular service, bearing in mind the handling of the firing, the supplies of water and fuel, etc.

2. For taking in the water at the intermediary stations, do you take a longer time than with the locomotives, on account of the less convenient arrangements? Have you had to fall back upon special fixings (hydrants, etc.), to make these easier, or do you make use of the same hydraulic cranes fitted up for the use of the locomotives?

3. Please give some information concerning the most difficult performances that you have been enabled to carry out with automotor-cars, from the point of view of effort of traction, the working of the boilers, and the speed (hauled load, average and maximum gradient and its length, maximum journey without stops, average *effective speed in full work realised* without excessive effort on said inclines, etc.).

Maximum speed realised on the level under good conditions of stability and with regular working of the automotor.

4. What remarks have you to make on the results obtained during regular working from the point of view of power and above all, the smoothness of working, bearing in mind the requirements of the service?

As regards the load and the time-table referred to in question II, have you not found any difficulty in the regularity of the travelling? Can you even make up for loss of time?

5. Have you found no difficulties in the upkeep : *a*) of the boiler; *b*) of the automotor, owing to its special and generally more delicate construction than that of the locomotives?

With particular reference to the boiler, have you not had trouble because of the quality of the water used?

In order to facilitate the up-keep of the engines, have you spare motor-trucks, in the case of the automotor-cars, with the motor-truck separable from the main under-frame.

6. Being given the necessity of storing and upkeeping the motor-cars in the locomotive sheds and the connection of the cars with the mechanical part, have you not had any trouble brought about by the deterioration of the car, particularly of the upholstering and the accessories, and by the difficulties of keeping it in a good state of cleanliness.

Have you not had trouble by the depots being encumbered on account of the length of the automotor-cars?

7. Have you often been compelled to put aside the automotor-cars, replacing them by locomotives on occasions of a great rush of passengers, recurrently (market-days, holidays, etc.); again at certain stated seasons (bathing, holidays, etc.), or yet again accidentally?

8. Have you found any advantage in reducing the classes to one only, even for trailing-cars?

9. Has the number of automotor-car journeys sandwiched between the already existing trains given rise to obstructions, to difficulties in the operations at the station, to delays to the principal trains, on the lines having a great number of express-trains and goods trains.

10. Average consumption of fuel per mile, including consumption for lighting and stoppages.

11. Average cost per mile for greasing, lighting, water, traction-staff, cleaning, upkeep of the mechanical part (including heavy and light repairs), and the upkeep of the car.

12. Data similar to those asked for by the questions number 10 and 11, for the small locomotives dealt with in question I-13, or for the ordinary tender-locomotives dealt with in question I-14.

13. Average price of the automotor-cars of your various types, in comparison with the price of the locomotives, dealt with in the fore-going question.

14. Have you other automotor-cars building? of what type? do you intend extending the use of them?

APPENDIX II.

Principal data referring to the automotor cars and small tank locomotives used for similar local services.

CHIEF PARTICULARS.	Name of railway at present using automotor cars.							
	Bavarian State Railway.					Saxon State Railway.		
	Steam cars.	Steam cars.	Accumulator cars.	Tank locomotives.	Tank locomotives.	Accumulator cars.	Steam cars.	Petrol cars
Series and class of automotor cars and locomotives	MBCi ... (Gänz.)	MCCi	MCi	PtL 2/2 ... (Maffei.)	PtL 2/2 ... (Krauss.)	E 1 N° 298 ...	S 1 (7) N° 300 ...	Dai 1 N° 299 ...
Nature and system of motor	Saturated steam, double expansion.	Superheated steam, single expansion.	Electric.	Superheated steam, single expansion.		Electric.	Superheated steam, single expansion.	Petrol (Daimler).
Total number of axles	2	4	2	2	2	2 + 2	2	2
Number of driving and coupled axles	1	2	2	2	2	4	1	1
Gauge of track	Standard.	Standard.	Standard.	Standard.	Standard.	Standard.	Standard.	Standard.
Total wheelbase, in metres	5·500 (18 ft. 9/16 in.)	15·705 (51 ft. 6 5/16 in.)	5·000 (16 ft. 4 7/8 in.)	2·900 (9 ft. 6 3/16 in.)	3·200 (10 ft. 6 in.)	12·730 (41 ft. 9 3/16 in.)	4·600 (15 ft. 1 1/8 in.)	4·800 (15 ft. 9 in.)
Rigid wheelbase, in metres	5·500 (18 ft. 9/16 in.)	2·750 (9 ft. 5/16 in.)	5·000 (16 ft. 4 7/8 in.)	2·900 (9 ft. 6 3/16 in.)	3·200 (10 ft. 6 in.)	4·000 (13 ft. 1 1/2 in.)	4·600 (15 ft. 1 1/8 in.)	4·800 (15 ft. 9 in.)
Arrangement of axles	...	With two bogies.	...	...	...	(5) With two independent trucks.	...	...
Length of body, in metres	10 000 (32 ft. 9 11/16 in.)	18·645 (61 ft. 2 in.)	11·540 (37 ft. 10 3/8 in.)	... ...	... ..	2 × 7·90 (25 ft. 11 in.)	9·730 (31 ft. 11 in.)	10·950 (35 ft. 11 in.)
Type of boiler	de Dion-Bouton.	Turgan. | Locomotive.	...	Locomotive.	Locomotive.	...	Serpollet.	...
Working pressure of boilers, in kilograms per square centimetre (in lb. per square inch.)	18 (256)	16 (228) | 16 (228)	... ...	12 (171)	12 (171)	... ...	30 (427)	...
Grate area, in square metres (in square feet)	0·300 (3·229)	0·830 (8·934) | 1·100 (11·84)	.. ...	0·830 (8·934)	0·600 (6·458)	...	...	...
Total heating surface, in square metres (in square feet)	8·400 (90·42)	42·00 (452·1) | 41·20 (443·4)	.. ...	35·700 (384·29)	28·900 (311·09)	...	...	...
Surface of superheater, in square metres (in square feet)	... ...	7·40 (79·66) | 7·00 (75·35)	... ...	6·60 (71·04)	8·10 (87·19)	...	...	...
Diameter of high-pressure cylinders, in milli-	116	200		265	280			

Length of stroke, in millimetres	140 (5 1/2 inches)	260 (1) (10 1/4 inches)	... ...	280 (1) (11 4/16 inches)	400 (1 ft. 3 3/4 in.)	...	...	...
Diameter of driving wheels at tread, in millimetres	1,000 (3 ft. 3 5/8 in.)	990 (3 ft. 3 in.)	990 (3 ft. 3 in.)	990 (3 ft. 3 in.)	1,006 (3 ft. 3 5/8 in.)	1,000 (3 ft. 3 3/8 in.)	1,000 (3 ft. 3 3/8 in.)	1,000 (3 ft. 3 3/8 in.)
Transmission of motion	Toothed gearing. (1 : 245-1 : 435.)	Direct, by rod and crank.	Toothed gearing.	Direct, by rod and crank.		Toothed gearing.	Direct, by rod and crank.	Toothed gearing.
Type of valve gear	...	Walschaerts.	...	Walschaerts.		...	Walschaerts.	...
Type of valve	Flat valve.	Piston valve.	...	Piston valve.		...	...	...
Class of fuel	Coke.	Bohemian coal (2).	...	Bohemian coal (2).		...	Coal	Petrol.
Capacity of water tanks, in cubic metres (in English gallons)	... ...	3·300 (726)	... ...	2·000 (440)	2·200 (484)	...	...	...
Capacity of fuel bunkers, in cubic metres (in cubic feet)	... ...	0·700 (24·722)	... ...	0·400 (14·127)	0·750 (26·487)	... ...	... ...	0·100 (3·532)
Weight of car or locomotive, empty, in tons (in English tons)	13·100 (12·89)	41·00 — 43·00 (40·35 — 42·32)	26·800 (26·38)	18·500 (18·21)	18·500 (18·21)	44·375 (42·69)	17·500 (17·22)	16·300 (16·04)
Weight of car or locomotive, in working order, but without passengers or luggage, in tons (in English tons)	14·400 (14·17)	47·00 — 48·00 (46·26 — 47·24)	26·800 (26·38)	22·100 (21·75)	22·700 (22·34)	44·375 (43·67)	... ...	16 400 (16·14)
Number of seats': 1st class	...	...	...	...	...	...	...	...
2nd class	9	...	...	...	...	...	...	...
3rd & 4th class	24 + 10	55 + 20	36 + 20	...	...	80 + 18	40 + 8	44 + 20
Total number of passengers	43	75	56	...	...	98	48	64
Approximate capacity of luggage compartment, in cubic metres (in cubic feet)	...	...	...	...	...	...	...	...
Total weight of car with passengers and luggage, in tons (in English tons)	17·400 (17·13)	53·00 — 54·00 (52·16 — 53·15)	30·600 (30·12)	...	...	51·720 (50·90)	21·100 (20·77)	20·200 (19·88)
Number of units of each type	1	7	1 (3)	60 (4)		1 (6)	1	1
System of brakes	Hand brake, on four wheels.	Westinghouse brake and Exner brake, on eight wheels.	Hand brake and electric brake, on four wheels.	Westinghouse brake.		Hand brake and electric brake, on eight wheels.	Hand brake, on four wheels.	Hand brake, on four wheels.
System of lighting	Paraffin.	Gas.	Electric.	...	...	Electric.	Oil.	Oil.
System of heating	Steam, Haag.	Steam, Haag.	Coal, stove.	Steam, Haag, for the train.		Coal stove.	Steam.	Hot water.

(1) Each cylinder contains two working pistons placed next each other, each acting on one axle of the locomotive; the two axles are coupled.
(2) The grate is fed semi-automatically by a charging-cone filled from the roof of the cab.
(3) Each axle of the car has a 48-horse-power motor. The capacity of the accumulator battery is 160 ampere-hours.
(4) Twenty of them under construction.
(5) The automotor is formed by the connexion of two vehicles, each with two independent axles.
(6) Each axle has a motor of 27 horse-power. The capacity of the accumulator battery is 430 ampere-hours.
(7) The Serpollet car is now not used.

Principal data referring to the automotor cars and small tank locomotives used for similar local services. (Continued.)

CHIEF PARTICULARS.	Name of railway at present using automotors cars.									
	Wurtemberg State Railway.				Austrian State Railway.					
	Steam cars.	Steam cars.	Petrol cars.	Steam cars.	Steam cars.	Steam cars.	Steam cars.	Petrol cars.	Tank locomotives.	Tank locomotives.
Series and class of automotor cars and locomotives	DW 1-4 ...	DW. 5-14 ...	BW 3-5 ...	DWss 1 ...	I 1001-1002 ...	I 1101 ...	2 2001 ...	19 19001 ...	185 185·01 ...	86 86·01 ...
Nature and system of motor	Superheated steam, single expansion.	Steam slightly superheated, single expansion.	Petrol (Daimler).	Steam slightly superheated, single expansion.	Steam slightly superheated, single expansion.		Steam strongly superheated, single expansion.	Petrol (Daimler).	Saturated steam, double expansion.	
Total number of axles	2	2	2	4	2	2	2	2	2	2
Number of driving and coupled axles	1	1	1	1	1	1	1	1	2	2
Gauge of track	Standard.	Standard.	Standard.	0·750 metre (2 ft. 5 1/2 in.).	Standard.	Standard.	Standard.	Standard.	Standard.	Standard.
Total wheelbase, in metres	4·600 (15 ft. 1 1/8 in.)	5·000 (16 ft. 4 7/8 in.)	4·800 (15 ft. 9 in.)	8·650 (28 ft. 4 9/16 in.)	5·000 (16 ft. 4 7/8 in.)	5·500 (18 ft. 9/16 in.)	5·300 (17ft. 4 11/16 in.)	4·000 (13 ft. 1 1/2 in.)	2·300 (7 ft. 6 9/16 in.)	2·500 (8 ft. 2 7/16 in.)
Rigid wheelbase, in metres	4·600 (15 ft. 1 1/8 in.)	5·000 (16 ft. 4 7/8 in.)	4·800 (15 ft. 9 in.)	2·200 (7 ft. 2 6/8 in.)	5·000 (16 ft. 4 7/8 in.)	5·500 (18 ft. 9/16 in.)	5·300 (17 ft. 4 11/16 in.)	4·000 (13 ft. 1 1/2 in.)	2·300 (7 ft. 6 9/16 in.)	2·500 (8 ft. 2 7/16 in.)
Arrangement of axles	...	...	...	With two bogies.	...	...	...	...	...	...
Length of body, in metres.	10·050 (32 ft. 11 11/16 in.)	10·420 (34 ft. 2 1/4 in.)	10·150 (33 ft. 3 5/8 in.)	11·300 (37 ft. 1 in.)	...	...	...	...	...	...
Type of boiler.	Serpollet.	Kittel.	...	Kittel.	Komareck I	Komareck II.	Serpollet.	...	Locomotive.	Locomotive.
Working pressure of boilers, in kilograms per square centimetre (in lb. per square inch.)	16 (228)	16 (228)	... ...	16 (228)	13 (185)	13 (185)	30 (427)	... ...	12 (171)	15 (213)
Grate area, in square metres (in square feet)	0·460 (4·952)	0·710 (7·643)	... ...	0·710 (7·643)	0·650 (6·497)	0·520 (5·595)	0·460 (4·952)	... ...	0·370 (3·983)	0·650 (6·997)
Total heating surface, in square metres (in square feet).	11·080 (119·27)	25·500 (274·49)	... ...	25·500 (274·49)	22·600 (243.27)	22·600 (243·27)	11·100 (119·48)	... ...	18·800 (202·37)	28·700 (308·94)
Surface of superheater, in square metres (in square feet).	... ...	9·50 (102·26)	... ...	9·50 (102·26)	3·00 (32·29)	3·00 (32·29)	... ...	... ...	... ...	... ...
Diameter of high-pressure cylinders, in millimetres	190 (7 1/2 in.)	220 (8 11/16 in.)	... ...	220 (8 11/16 in.)	250 (9 15/16 in.)	250 (9 15/16 in.)	190 (7 1/2 in.)	... ...	180 (7 1/16 in.)	230 (9 1/16 in.)

Diameter of driving wheels at tread, in millimetres	1,000 (3 ft. 3 3/8 in.)	1,000 (3 ft. 3 3/8 in.)	1,000 (3 ft. 3 3/8 in.)	900 (2 ft. 11 7/16 in.)	980 (3 ft. 2 7/8 in.)	1,000 (3 ft. 3 3/8 in.)	1,000 (3 ft. 3 3/8 in.)	950 (3 ft. 1 3/8 in.)	800 (2 ft. 7 1/2 in.)	950 (3 ft. 1 3/8 in.)
Transmission of motion	Direct, by rod and crank.	Direct, by rod and crank.	Toothed gearing.	Direct, by rod and crank.	Direct, by rod and crank.			Toothed gearing.	Direct, by rod and crank.	
Type of valve gear	Walschaerts.	Walschaerts.	...	Walschaerts.	Walschaerts.	Walschaerts.	Walschaerts.	...	Joy modified.	
Type of valve	Flat valve.	Flat valve.	...	Flat valve.	Flat valve.	Flat valve.	Flat valve.	...	Flat valve.	
Class of fuel	Briquettes.	Coal.	Petrol.	Coal.	Coal.	Coal.	Coal.	Petrol.	Coal and heavy oil.(8)	
Capacity of water tanks, in cubic metres (in English gallons)	0·820 (180)	1·500 (330)	... ...	1·500 (330)	1·440 (317)	1·600 (352)	0·820 (180)	... ...	1·200 (264)	2·100 (462)
Capacity of fuel bunkers, in cubic metres (in cubic feet)	0·270 (9·535)	0·620 (21·896)	0·100 (3·532)	0·400 (14·127)	0·400 (14.127)	0·600 (21·190)	0·300 (10·595)	0·140 (4·944)	0·340 (12·008)	0·500 (17·658)
									0·330 (11·655)	0·500 (17·658)
Weight of car or locomotive, empty, in tons (in English tons)	16·680 (16·42)	17·500 (17·22)	12·500 (12·30)	18·560 (18·27)	21·400 (21·06)	21·200 (20·87)	17·500 (17·22)	12·950 (12·75)	12·300 (12·10)	16·600 (16·34)
Weight of car or locomotive, in working order, but without passengers or luggage, in tons (in English tons)	17·900 (17·62)	21·000 (20·67)	12·600 (12·40)	21·460 (21·12)	... ...	... ...	... ...	13 090 (12·88)	15·700 (15·45)	21·100 (20·77)
Number of seats : 1st class	...	...	...	...	...	...	...	...	...	...
2nd class	...	...	...	16	8	...	8	16	...	...
3rd & 4th class	40 + 8	40 + 4	44 + 8	24 + 8	24	35	30	12 + 6	...	...
Total number of passengers	48	44	52	48	32	35	38	34	...	...
Approximate capacity of luggage compartment, in cubic metres (in cubic feet)	... ...	... ...	... ...	... ...	2·00 (70)	2·00 (70)	1·00 (35)	... ...	... ...	... ...
Total weight of car with passengers and luggage, in tons (in English tons)	21·200 (20·87)	24·300 (23·92)	16·150 (15·89)	24·750 (24·36)	27·200 (26·77)	26·900 (26·48)	21·900 (21·55)	15·640 (15·39)	... ...	... ...
Number of units of each type	4	10	4	1	2	1	1	1	1	1
System of brakes	Hand brake, and Westinghouse brake on four wheels.		Hand brake, on four wheels.	Hand brake, and Westinghouse brake, on eight wheels.	Hand brake, and vacuum brake.	Hand brake, and automatic vacuum brake.	Hand brake.	Hand brake.	Vacuum brake.	Vacuum brake.
System of lighting	Oil.	Oil.	Oil.	Oil.	Oil.	Oil.	Oil.	Oil.	...	...
System of heating	Steam.	Steam.	Hot water.	Steam.	Steam.	Steam.	Steam.	Hot water.	Steam for the train.	Steam for the train.

(8) Heavy oils are burnt by means of Holden burners; of the figures for the bunker capacity, the upper refers to carbon, the lower to liquid fuel.

Principal data referring to the automotor cars and small tank locomotives used for similar local services. (Continued.)

CHIEF PARTICULARS.	Name of railway at present using automotor cars.							
	Austrian Southern Railway.	Belgian State Railway.			Belgian Suburban Railway.	French State Railway.		
	Steam cars.	Steam cars.	Steam cars.	Accumulator cars.	Steam cars.	Steam cars.	Tank locomotives.	Tank locomotives.
Series and class of automotor cars and locomotives.	... ... (Ganz.)	1st pattern. ... (Belpaire.)	2nd pattern. ... (Belpaire.)	(9)	(11) ... ... (Rowan.)	... 0101 (Purrey.)	... 0221-0230 ...	... 0241-0250 ...
Nature and system of motor	Saturated steam, double expansion.	Saturated steam, single expansion.		Electric.	Saturated steam, single expansion.	Steam slightly superheated, double expansion.	Saturated steam, single expansion.	
Total number of axles	2	3	4	4	3	2	3	4
Number of driving and coupled axles	1	2	2	2	2	1	2	2
Gauge of track	Standard.	Standard.	Standard.	Standard.	1·067 metres. (3 ft. 6 in.)	Standard.	Standard.	Standard.
Total wheelbase, in metres	6·000 (19 ft. 8 1/4 in.)	4·100 (13 ft. 5 7/16 in.)	9·680 (31 ft. 9 1/8 in.)	13·870 (45 ft. 6 in.)	... ...	5·850 (19 ft. 2 5/16 in.)	... ...	... ...
Rigid wheelbase, in metres	6.000 (19 ft. 8 1/4 in.)	4·100 (13 ft. 5 7/16 in.)	4·600 (15 ft. 1 1/8 in.)	2·470 (8 ft. 1 1/4 in.)	... ...	5·850 (19 ft. 2 5/16 in.)	... ...	... ...
Arrangement of axles.	...	...	3 rigid, 1 with radial axle-boxes.	With two bogies.	One motor truck and one rigid axle.	...	...	...
Length of body, in metres	11·130 (36 ft. 6 3/16 in.)	... ...	11·060 (36 ft. 3 7/16 in)	17·180 (56 ft. 4 3/8 in.)	... ...	11·325 (37 ft. 1 7/8 in.)	... ...	... ...
Type of boiler	de Dion-Bouton	Belpaire (locomotive).	Belpaire (locomotive).	...	Rowan.	Purrey.	Locomotive.	Locomotive.
Working pressure of boilers, in kilograms per square centimetre (in lb. per square inch.)	18 (256)	12 (171)	12 (171)	... ...	... ...	20 (284)	12 (171)	12 (171)
Grate area, in square metres (in square feet)	0·330 (3 552)	1·080 (11·625)	1·080 (11·625)	... ...	... ...	0 840 (9·042)	0·824 (8·870)	1·200 (12·92)
Total heating surface, in square metres (in square feet)	8·600 (92·57)	26·940 (289·99)	26·430 (284·50)	... ...	... ...	19·600 (210·98)	30·550 (328·85)	37·800 (406·89)
Surface of superheater, in square metres (in square feet)	... ...	... ...	... ...	... ...	... ...	6·40 (68·89)	... ...	... ...
Diameter of high-pressure cylinders, in millimetres (in inches)	116	250	200	...	230	2 × 140	250	200

Length of stroke, in millimetres	140 (5 1/2 inches)	350 (1 ft. 1 13/16 in.)	350 (1 ft. 1 13/16 in.)	... ...	330 (1 ft. 1 in.)	200 (7 7/8 inches)	400 (1 ft. 3 3/4 in.)	400 (1 ft. 3 3/4 in.)
Diameter of driving wheels at tread, in millimetres	1,000 (3 ft. 3 3/8 in.)	980 (3 ft. 2 5/8 in.)	980 (3 ft. 2 5/8 in.)	1,010 (3 ft. 3 3/4 in.)	750 (2 ft. 5 1/2 in.)	1,050 (3 ft. 5 3/8 in.)	1,320 (4 ft. 4 in.)	1,320 (1 ft. 4 in.)
Transmission of motion	Toothed gearing.	Direct, by rod and crank.		Toothed gearing.	Direct, by rod and crank.	Chain.	Direct, by rod and crank.	
Type of valve gear	...	Walschaerts.		...	...	Purrey Stephenson.	...	Walschaerts.
Type of valve	Flat valve.	Flat valve.		...	...	Flat valve.	Flat valve.	Piston valve.
Class of fuel	Coal.	Coal.		...	Coal.	Coke.	Coal.	Coal.
Capacity of water tanks, in cubic metres (in English gallons)	1·050 (231)	2·940 (647)	... ...	... ...	0·900 (198)	1·450 (319)	... ...	... ...
Capacity of fuel bunkers, in cubic metres (in cubic feet)	0·400 (14·127)	0·550 (19·424)	... ...	... ...	... ...	0·600 (21·190)	... ...	... ...
Weight of car or locomotive, empty, in tons (in English tons)	16·050 (15·80)	19·800 (19·49)	24·160 (23·78)	... ...	14·300 (14·07)	19·000 (18·70)	21·500 (21·16)	27·000 (26·57)
Weight of car or locomotive, in working order, but without passengers or luggage, in tons (in English tons)	17·500 (17·22)	... ...	... ...	... ...	15·600 (15·35)	21·000 (20·67)	... ...	... ...
Number of seats: 1st class	...	...	...	...	12	...	...	...
Number of seats: 2nd class	11	...	23	30	16	8	...	...
Number of seats: 3rd & 4th class	30	15	30	36 + 12	10	16 + 12	...	...
Total number of passengers	41	15	53	78	38	36	...	...
Approximate capacity of luggage compartment, in cubic metres (in cubic feet)	6·00 (212)	6·00 (212)	... ...	... ...	3·50 (124)	8·00 (283)	... ...	... ...
Total weight or car with passengers and luggage, in tons (in English tons)	20·880 (20·55)	19·800 (18·70)	33·100 (32·58)	... ...	18·600 (18.30)	24·000 (23·62)	26·600 (26·18)	33·500 (32·97)
Number of units of each type	2	14	3	1 (10)	2	2	...	...
System of brakes	Vacuum brake and hand brake.	Westinghouse automatic continuous brake.			Hand brake.	Screw brake and Wenger brake.	Screw brake and Wenger continuous brake.	
System of lighting	Acetylene.	Oil.	Oil.	Electric.	Paraffin.	Acetylene, electricity.	...	...
System of heating	Steam.	Stoves and coke.			...	Steam.	...	...

(9) The electric accumulator car is in use as an experiment.

(10) Two axles, one on each bogie, have a 75-kilowatt motor.

(11) The Rowan automotor cars have been withdrawn from service.

Principal data referring to the automotor cars and small tank locomotives used for similar local services. (Continued.)

CHIEF PARTICULARS.	Name of railway at present using automotor cars.							
	Paris-Orléans-Railway.		Paris-Lyons-Mediterranean-Railway.				St-Quentin Railway.	Swiss Federal Railway.
	Steam cars.	Steam cars.	Steam cars.	Steam cars.	Steam cars.	Steam cars.	Steam cars.	Petrol cars.
Series and class of automotor cars and locomotives.	AV 1 ... (Purrey.)	AV 2-AV 11 ... (Purrey.)	VACf 1-2 ... (Purrey.)	VACf 3-6 ... (Purrey.)	VACf [12] 11-12 ... (Serpollet.)	VACEf 21-32 ... (Purrey.)	... ...	.. ... (Daimler.)
Nature and system of motor	Steam slightly superheated, double expansion.		Steam slightly superheated, double expansion.		Steam strongly superheated, single expansion.	Steam slightly superheated, double expansion.	Saturated steam, single expansion.	Petrol.
Total number of axles.	3	3	2	2	2	3	4	2
Number of driving and coupled axles	1	1	1	1	1	1	[13]	1
Gauge of track.	Standard.	Standard.	Standard.	Standard.	Standard.	Standard.	1·000 metre. (3 ft. 3 3/8 in.)	Standard.
Total wheelbase, in metres	8·200 (26 ft. 10 13/16 in.)	11·400 (37 ft. 5 in.)	5·850 (19 ft. 2 5/16 in.)	5·850 (19 ft. 2 5/16 in.)	5·950 (19 ft. 6 6/16 in.)	12·400 (40 ft. 8 3/16 in.)	7·700 (25 ft. 3 3/16 in.)	4·800 (15 ft. 9 in.)
Rigid wheelbase, in metres.	8·200 (26 ft. 10 13/16 in.)	3·200 (10 ft. 6 in.)	5·850 (19 ft. 2 5/16 in.)	5·850 (19 ft. 2 5/16 in.)	5·950 (19 ft. 6 6/16 in.)	3·200 (10 ft. 6 in.)	1·400 (4 ft. 7 1/8 in.)	4·800 (15 ft. 9 in.)
Arrangement of axles.	The 2 end axles have radial axle-boxes.	1 independent motor truck and 1 rigid axle.	...	...	...	1 independent motor truck and 1 rigid axle.	With 2 bogies.	...
Length of body, in metres	... ...	12·910 (42 ft. 4 7/16 in.)	11·200 (36 ft. 9 in.)	11·940 (39 ft. 2 in.)	10·790 (35 ft. 4 13/16 in.)	13·190 (42 ft. 3 7/16 in.)	10·094 (33 ft. 1 3/8 in.)	10·150 (33 ft. 3 6/8 in.)
Type of boiler	Purrey.	Purrey.	Purrey.	Purrey.	Serpollet.	Purrey.	Vertical, with Field tubes.	...
Working pressure of boilers, in kilograms per square centimetre (in lb. per square inch.)	20 (284)	20 (284)	20 (284)	24 (341)	94 (1,337)	20 (284)	12·5 (178)	... ..
Grate area, in square metres (in square feet)	0·840 (9·042)	1·080 (11·625)	0·840 (9·042)	0·866 (9·322)	Petroleum burner.	1·080 (11·625)	0·440 (4·736)	... ...
Total heating surface, in square metres (in square feet)	19·600 (210·98)	24·560 (264·37)	19·600 (210·98)	19·600 (210·98)	17·730 (190·85)	24·560 (264·37)	20·440 (220·02)	... ...

Diameter of low-pressure cylinders, in millimetres	2 × 200 (2 × 7 7/8 in.)	2 × 220 (2 × 8 11/16 in.)	2 × 200 (2 × 7 7/8 in.)	2 × 200 (2 × 7 7/8 in.)	... ...	2 × 220 (2 × 8 11/16 in.)	... ...	... ...
Length of stroke, in millimetres	200 (7 7/8 inches)	225 (8 7/8 inches)	200 (7 7/8 inches)	200 (7 7/8 inches)	200 (7 7/8 inches)	225 (8 7/8 inches)	300 (11 13/16 inches)	... ...
Diameter of driving wheels at tread, in millimeters	1,050 (3 ft. 5 3/8 in.)	1,050 (3 ft. 5 3/8 in.)	1,050 (3 ft. 5 3/8 in.)	1,000 (3 ft. 3 3/8 in.)	920 (3 ft. 1/4 in.)	1,400 (3 ft. 5 in.)	750 (2 ft. 5 1/2 in.)	1,020 (3 ft. 4 9/16 in.)
Transmission of motion	Chain.	Chain.	Chain.	Chain.	Direct, by rod and crank.	Chain.	Direct, by rod and crank.	Toothed gearing.
Type of valve gear	Purrey-Stephenson.		Purrey-Stephenson.		With valve.	Purrey-Stephenson.	Walschaerts.	...
Type of valve	Flat valve		Flat valve.		...	Flat valve.	...	...
Class of fuel	Coke.	Coke.	Coke.	Coke.	Petroleum.	Coke.	Coal.	Petrol.
Capacity of water tanks, in cubic metres (in English gallons)	1·280 (282)	1·250 (275)	1·450 (319)	1·790 (394)	0·210 (46)	1·540 (339)	... ...	... ...
Capacity of fuel bunkers, in cubic metres (in cubic feet)	0·320 (11·300)	0·600 (21·190)	0·600 (21·190)	1·000 (35·316)	0·210 (7·416)	0·800 (28·253)	... .	0·120 (4·238)
Weight of car or locomotive, empty, in tons (in English tons)	23·230 (22·86)	26·950 (26·52)	19 100 (18·80)	20·000 (19·68)	17·900 (17·62)	29·770 (29·30)	16·150 (15·90)	12·830 (12·63)
Weight of car or locomotive, in working order, but without passengers or luggage, in tons (in English tons)	... ...	... ...	20 830 (20·50)	22·200 (21·85)	18·320 (18·03)	31·640 (31·14)	20·150 (19·83)	12·950 (12·75)
Number of seats: 1st class	26	25	12	10	12	12	6	...
Number of seats: 2nd class	...	...	...	...	...	...	12	...
Number of seats: 3rd & 4th class	...	30	24 + 12	29 + 12	29 + 12	47	25	46 + 8
Total number of passengers	26	55	48	51	53	59	43	54
Approximate capacity of luggage compartment, in cubic metres (in cubic feet)	15 — 20 (530 — 706)	15 — 20 (530 — 706)	... ...	... ...	... ...	13·00 (459)	3·00 (106)	... ...
Total weight of car with passengers and luggage, in tons (in English tons)	28·500 (28·05)	34·800 (34·25)	24·190 (23·81)	25·770 (25·36)	22 100 (21·75)	35·780 (35·21)	24·000 (23 62)	16·950 (16·68)
Number of units of each type	1	10	2	4	2	12	3	1
System of brakes	Westinghouse brake.	Westinghouse brake and screw brake.	Westinghouse continuous automatic and graduated brake and hand brake.				Hand brake and Westinghouse brake.	Hand brake on four wheels.
System of lighting	...	Oil.	Oil.	Oil.	Oil.	Oil.	Paraffin.	Paraffin.
System of heating	Steam.	Steam.	Steam.	Steam.	Steam.	Steam.	Steam.	Hot water.

(12) The Serpollet car has been withdrawn from service.

(13) No information has been supplied on this point.

Principal data referring to the automotor cars and small tank locomotives used for similar local services. (Continued.)

CHIEF PARTICULARS.	Name of railway at present using automotor cars.				Railways at present using small tank locomotives only.			
	Italian State Railway.				French Western Railway.	Norwegian State Railway.		Aussig-Teplitz Railway.
	Steam cars.	Steam cars.	Steam cars.	Steam cars.				
Series and class of automotor cars and locomotives.	60	80 ... (Purrey.)	85 ... (Kerr-Stuart.)	86 ... (Kerr-Stuart.)	0101-0138	I	II	... ...
Nature and system of motor	Saturated steam, single expansion.	Steam slightly superheated, double expansion.	Saturated steam, single expansion.		Saturated steam, single expansion.	Saturated steam, single expansion.		Saturated steam, single expansion.
Total number of axles	3	2	4	4	3	3	3	2
Number of driving and coupled axles	2	1	1	2	1	2	2	2
Gauge of track	Standard.	Standard.	Standard.	Standard.	Standard.	1·067 metres. (3 ft. 6 in.)	1·067 metres. (3 ft. 6 in.)	Standard.
Total wheelbase, in metres	4·600 (15 ft. 1 1/8 in.)	5·865 (19 ft. 2 13/16 in.)	15·651 (51 ft. 4 3/16 in.)	16·191 (53 ft. 1 1/2 in.)	3·960 (12 ft. 11 15/16 in.)	4·340 (14 ft. 2 7/8 in.)	3·505 (11 ft. 6 in.)	2·300 (7 ft. 6 9/16 in.)
Rigid wheelbase, in metres	4·600 (15 ft. 1 1/8 in.)	5·865 (19 ft. 2 13/16 in.)	2·971 (9 ft. 8 15/16 in.)	2·438 (8 feet)	3·960 (12 ft. 11 15/16 in.)	1·900 (6 ft. 2 13/16 in.)	1·520 (4 ft. 11 13/16 in.)	2·300 (7 ft. 6 9/16 in.)
Arrangement of axles	...	...	1 independent motor truck and 1 bogie.	With 2 bogies, one of them motor.	...	With leading Bissel.		...
Length of body, in metres	8·510 (27 ft. 11 in.)	8·730 (15) (28 ft. 7 11/16 in.)	14·660 (15) (48 ft. 1 3/16 in.)	18·957 (62 ft. 2 5/16 in.)	... ...	... ...	... ...	... ...
Type of boiler	Vertical (14) with smoke tubes. / Komareck.	Purrey.	Transverse, locomotive type.	Locomotive.	Locomotive.	Locomotive.	Locomotive.	Locomotive.
Working pressure of boilers, in kilograms per square centimetre (in lb. per square inch.)	13 (185) / 13 (185)	20 (284)	12 (171)	12 (171)	8·5 (121)	9·14 (130)	8·46 (120)	12 (171)
Grate area, in square metres (in square feet)	1·000 (10 764) / 0·724 (7·793)	0·840 (9·042)	0·670 (7·212)	0·830 (8·934)	0·870 (9·365)	0·670 (7·212)	0·410 (4·413)	0·700 (7·535)
Total heating surface, in square metres (in square feet)	60·00 (645.86) / 42·20 (454·25)	19·600 (210·98)	38·800 (417·65)	46·600 (502·62)	53·700 (578·04)	34·700 (373·52)	21·400 (231·36)	36·200 (389·67)
Surface of superheater, in square metres (in square feet)	... ... / 6·50 (69·97)	6·40 (68·89)	... ...	... ...	... ...	... ...	... ...	... ...
Diameter of high-pressure cylinders, in millimetres	290 (11 7/16 inches)	2 × 140 (2 × 5 1/2 in).	228 (8 31/32 in.)	254 (10 inches)	317 (1 ft. 1/2 in.)	279 (11 inches)	229 (9 inches)	260 (10 1/4 inches)
Diameter of low-pressure cylinders, in millimetres	...	2 × 200	...	...	...	...	...	...

Diameter of driving wheels at tread, in millimetres	1,115 (3 ft. $7\frac{15}{16}$ in.)	980 (3 ft. $2\frac{5}{8}$ in.)	1,042 (3 ft. 5 in.)	1,042 (3 ft. 5 in.)	1,740 (5 ft. $8\frac{1}{2}$ in.)	1,143 (3 ft. 9 in.)	1,143 (3 ft. 9 in.)	850 (2 ft. $9\frac{1}{2}$ in.)
Transmission of motion	Direct, by rod and crank.	Chain.	Direct, by rod and crank.		Direct, by rod and crank.	Direct, by rod and crank.		Direct, by rod and crank.
Type of valve gear	Walschaerts.	Purrey-Stephenson.	Walschaerts.		Stephenson.	...	...	...
Type of valve	Piston valve.	Flat valve.	Flat valve.		Flat valve.	Flat valve.		Flat valve.
Class of fuel	Coal.	Coke.	Coal.		Coal.	Coal.		Coal.
Capacity of water tanks, in cubic metres (in English gallons)	3·200 (704)	1·420 (313)	1·800 (396)	2·000 (440)	2·100 (462)	1·200 (264)	0·900 (198)	2·350 (517)
Capacity of fuel bunkers, in cubic metres (in cubic feet)	1·200 (42·380)	0·600 (21·190)	1·200 (42·380)	1·200 (42·380)	... ...	0·400 (14·126)	0·300 (10·595)	0·800 (28·253)
Weight of car or locomotive, empty, in tons (in English tons)	27·300 (26·87)	21·000 (20·67)	38·500 (37·89)	40·500 (39·86)	20·050 (19·73)	16·800 (16·53)	11·100 (10·92)	16·400 (16·14)
Weight of car or locomotive, in working order, but without passengers or luggage, in tons (in English tons)	32·800 (32·28)	22·900 (22·54)	42·500 (41·83)	45·100 (44·39)	25·370 (24·97)	19·600 (19·29)	13·200 (12·99)	19·000 (18·70)
Number of seats : 1st class	...	8	16	16	...	...	...	...
Number of seats : 2nd class	...	...	...	...	...	...	...	...
Number of seats : 3rd & 4th class	...	16 + 10	50	50	...	...	...	...
Total number of passengers	...	34	66	66	...	...	...	...
Approximate capacity of luggage compartment, in cubic metres (in cubic feet)	13·00 (459)	6·00 (212)	2·50 (88·3)	3·00 (106)	... ...	... ...	... ...	... ...
Total weight or car with passengers and luggage, in tons in English tons)	34·000 (33·46)	26·000 (25·59)	46·500 (45·77)	49·100 (48·32)	... ...	... ...	... ...	... ...
Number of units of each type	85	3	3	12	...	...	...	...
System of brakes	Hand brake and Westinghouse brake.				Hand brake and Westinghouse brake.	...	...	...
System of lighting	Oil.	Electric.	Acetylene.	Acetylene.	...	...	...	...
System of heating	Steam.	Steam.	Steam.	Steam.	...	...	...	...

(14) At present two other types of boilers are being tried for these motor luggage-vans; one vertical with smoke tubes, but with enlarged barrel, the dimensions being nearly the same as in the normal type; the other is a horizontal boiler of the locomotive type, placed crosswise, with very short smoke tubes, a grate area of 1 square metre (10·764 square feet), and a heating surface of 52·25 square metres (562·435 square feet) (Serve tubes).

(15) Without the boiler room.

Remarks : *A*. The Baden State Railway has tried, as an experiment, a Serpollet steam car with two axles, similar to those of the Wurtemberg State Railway, and an electric accumulator car. At present these cars are not used any more. *B*. The automotor cars with internal-combustion motors considered in the table all have mechanical transmissions. No information has reached us from any administrations owning cars with internal-combustion motors and electric transmission (benzo-electric, Weitzer type, etc.) except the Belgian National Suburban, which has recently decided to try a new type of car on the "Automixed" system based on the combined use of petrol or poor-gas motor, a dynamo, an accumulator battery and electric motors. *C*. The Swiss Federal Railway formerly had a Serpollet car in use, subsequently withdrawn from service.

[621 .132.8 & 621 .33]

REPORT N° 3

(Great Britain and colonies)

By Mr. T. Hurry RICHES,

LOCOMOTIVE CARRIAGE AND WAGON SUPERINTENDENT TAFF VALE RAILWAY.

From enquiries made of the various railway companies in Great Britain and her Colonies, it is found that on the twenty-one railways, named below, motor cars have been experimented with and put into ordinary traffic.

It will be seen that in almost every case some improvements or developments have taken place since the first cars were introduced on the respective lines herein dealt with.

It may be taken that self-contained railway motor cars are essentially useful for the opening up of new traffic, and also for dealing with small traffic in sparsely populated districts.

They are also most useful for small and frequent services, between points of moderate distance apart, and for suburban traffic generally, where it is not too heavy.

The drawings and particulars attached to this report will enable all to appreciate the general design and construction of these self-contained cars.

It may be stated broadly that the majority of railway companies in Great Britain use small boilers of locomotive type for their steam motor cars, such as the London & North Western Railway, Lancashire & Yorkshire Railway, and a few others, whilst the Great Western Railway, and some other companies use vertical boilers with multiple tubes. The Taff Vale Railway use a special boiler with a locomotive fire-box in the middle, and two short barrel ends fitted with a number of small

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tubes. This boiler in fact is after the style of the boiler used many years ago in Fairley's double ended locomotives.

It may also be stated that the Lancashire & Yorkshire Railway, and a few others use the Walschaerts Gear for the motion, while the remaining companies use the ordinary Stephenson or straight link motion.

The speeds attained with these motor cars range from 45 miles per hour on some lines down to 25 miles per hour on others, and these cars whenever needed can negotiate inclines as steep as one in 38.

So much for the initiatory stages of railway motor car service.

The next development to be referred to is where these small cars are made to take with them, when necessary, another, or trailing car, to meet the increase in passengers at certain periods of the day.

The third stage is where these self-contained motor cars have a carriage attached to them, generally speaking, in front of the engine, and so fitted, that the motor car engine which pushes it along, may be actuated and controlled from a compartment in the leading end of this carriage.

A still further development is that of an ordinary locomotive, of small type, specially fitted, and placed between two carriages — each of these carriages being equipped with a drivers compartment, at the end farthest from the engine so as to enable the engine to be actuated from either one of these compartments, whichever happens to be leading.

From this compartment the driver, who rides in it, has complete control of the train, the fireman, or assistant motorman remains on the footplate to attend to the engine, there being electrical communication between the motorman and his assistant.

The foregoing covers the various arrangements which are in existence for this particular class of traffic, and the particulars attached will in each case show the details of the several arrangements in use on the different lines reported upon.

To summarise. To enable the railway companies to meet the competition which had arisen in many suburban districts with electrical and other cars for street traffic, they were compelled to seek a method of providing a much more frequent service, and at the same time, one that could be worked at a much less cost per mile, than had been possible before with ordinary suburban trains. This object has been largely achieved by the adoption of these self-contained motor cars and motor trains, so far as, what may be termed " longer distance " traffic is concerned, and which otherwise might have been carried by street cars. It will of course be realised that railway companies cannot successfully compete with what we may call " door to door traffic ", but wherever passengers require to go a mile or two, the increased speed of the railway, makes their motor car service attractive to the public, as well as profitable to themselves, the cost per mile being about one third of what it is with an ordinary passenger train.

It seems to me that the drawings and particulars supplied herewith will make the

matter perfectly clear to those who desire information on the subject. I think perhaps it may be advisable for me to say, as one who has had a good deal of experience in the desiging and running of these motor cars, that any man who aims a designing motor cars will find it not nearly so simple a matter as designing an ordinary locomotive.

There are so many little and intricate circumstances and conditions, which bear upon and influence one another, that before anyone attempts to build a motor car, it is quite essential that every circumstance likely to arise in connection with such a vehicle, should be most carefully considered.

The following is a list of the railway companies who have replied to the questions :

Alexandra (Newport) Docks and Railway Company;
Furness Railway Company;
Great Central Railway Company;
Great Western Railway Company;
Lancashire & Yorkshire Railway Company;
London & North Western Railway Company;
London, Brighton & South Coast Railway Company;
Midland Railway Company;
North Staffordshire Railway Company;
North Eastern Railway Company;
Port Talbot Railway & Docks Company;
Rhymney Railway Company;
South Eastern & Chatham Railway Company;
Taff Vale Railway Company;
Dublin & South Eastern Railway Company (Ireland);
Great Northern Railway Company (Ireland);
Central South African Railway Company;
South Australian Government Railways;
Great Indian Peninsula Railway Company;
Madras & Southern Mahratta Railway Company;
North Western State Railway of India.

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APPENDIX I.

Summary of replies to detailed list of questions relating to question XII.

QUESTION 1. — *Description of railway auto-motor cars. — a) What are the various types of automotor cars or motor luggage vans in use on the railway. — b) If driven by steam, oil gas or electricity.*

The following railways have automotor cars in use, driven by steam, except where otherwise stated. The principal type is with engine and car combined, capable of being driven from the car end as well as from the engine.

On some of the lines, as stated against them, they run an ordinary locomotive of small type either with one carriage attached, capable of being driven from the leading end of carriage as well as from the engine, or with the engine placed between two carriages, also capable of being driven from either end according to which carriage is leading.

These are referred to below (where in use) for the sake of brevity as "Short Motor Trains".

The various types of auto-car are shewn on the drawings supplied.

REPLIES OF RAILWAYS TO WHICH ABOVE REMARKS APPLY.

Alexandra (Newport) Docks & Railway Company. — Ordinary type. Combined engine and car.

Furness Railway. — Ordinary type. Combined engine and car.

Great Central Railway. — Ordinary type. Combined engine and car.

Great Western Railway. — Ordinary type. Combined engine and car; Also "short motor trains".

Lancashire & Yorkshire Railway. — Ordinary type. Combined engine and car.

London & North Western Railway. — Ordinary type. Combined engine and car.

London, Brighton & South Coast Railway. — Class 1 : Auto steam car. Combined engine and car. Class 2 : "Short motor train". Class 3 : Petrol engine coaches with motor of pleasure road car type. Class 4 : Petrol Electric Coaches. Petrol motor driving dynamo to charge accumulators which afterwards drive the car, the dynamo becoming the motor and the petrol engine assisting if necessary.

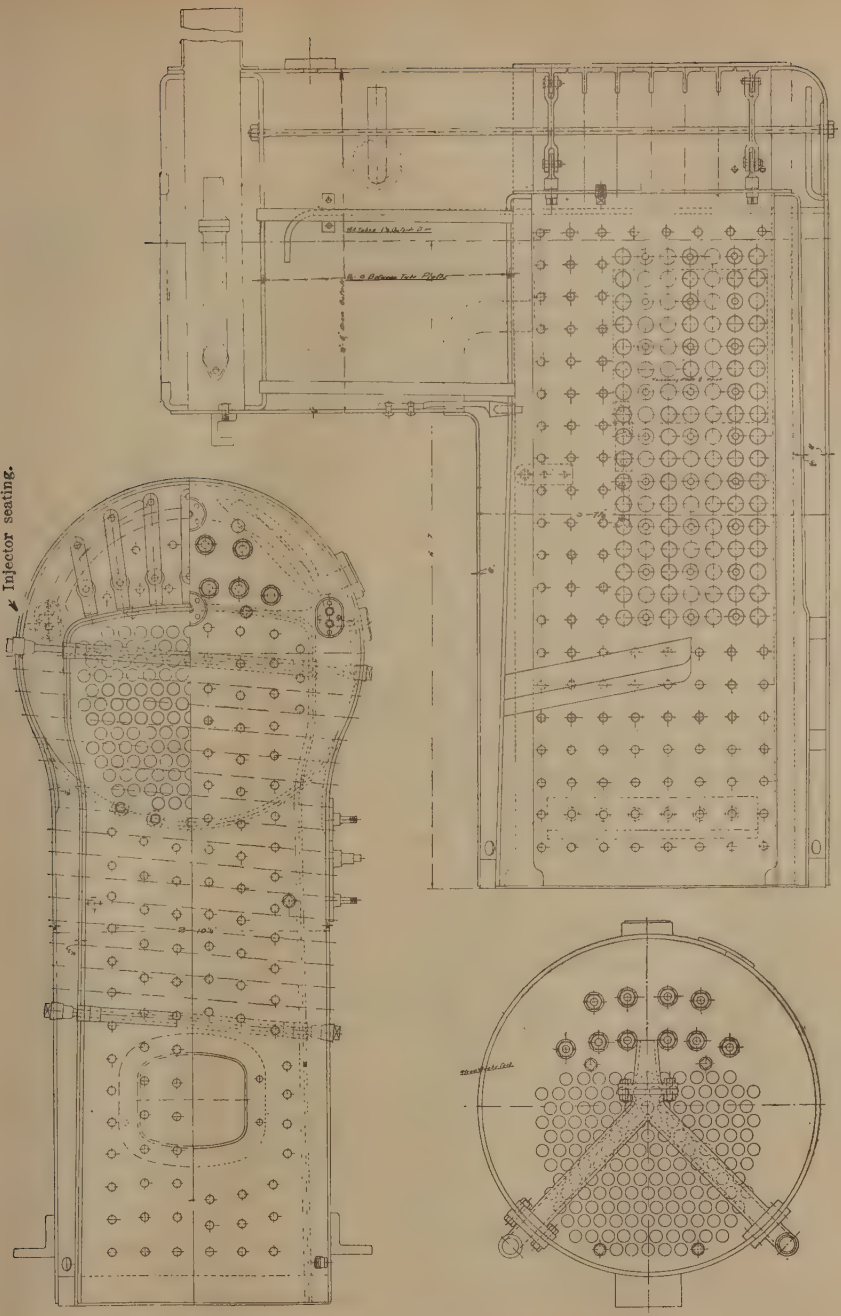


Fig. 1. — Alexandra (Newport) Docks & Railway. — Boiler No. 1 steam motor carriage.

Heating surface of smoke tubes	. . . . .	152	square feet.	
— — of water-tubes	. . . . .	119	—	—
— — of fire-box	. . . . .	76	—	—
Total.	. .	347	square feet.	

Fire-grate area : 7 square feet.

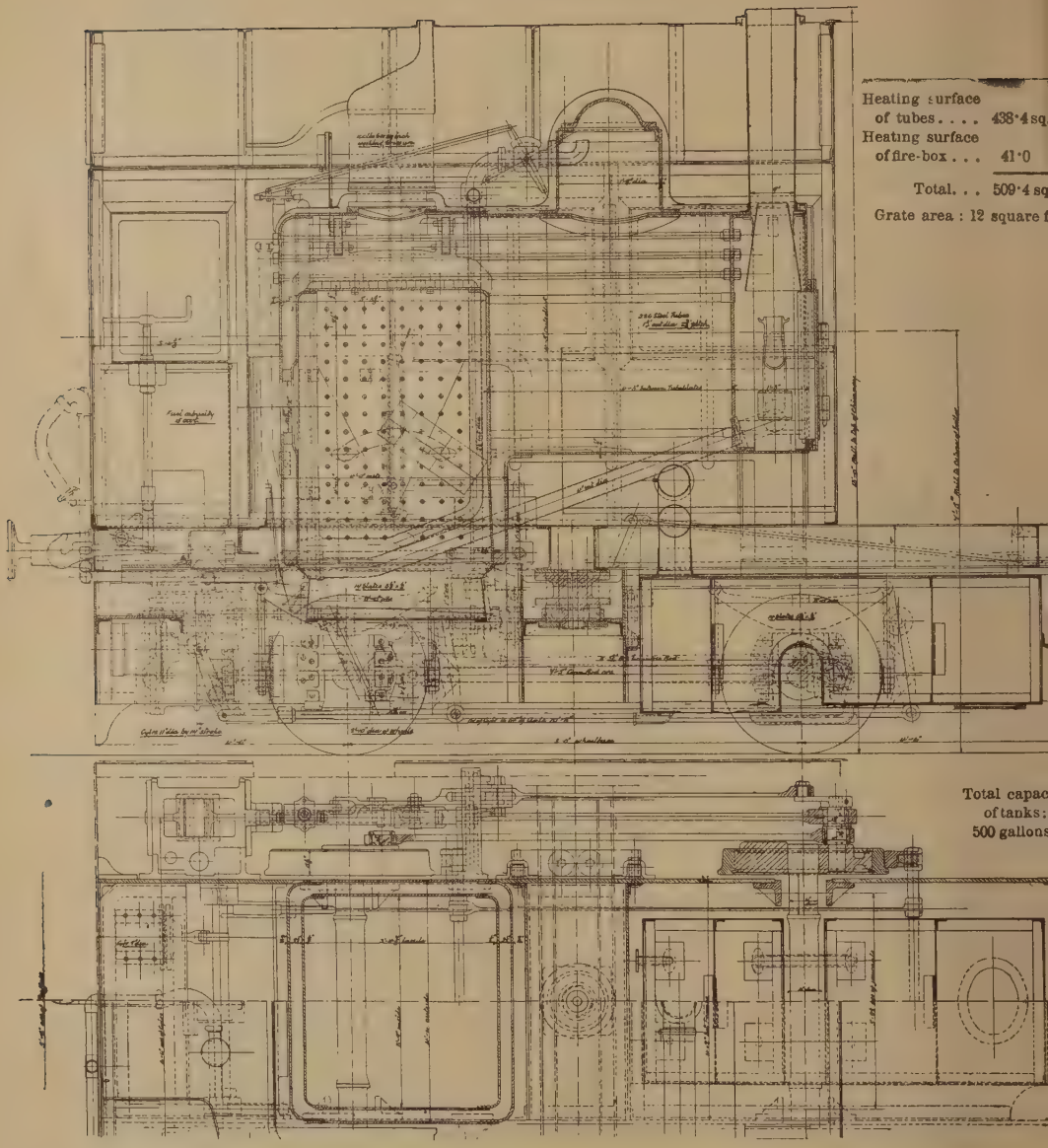
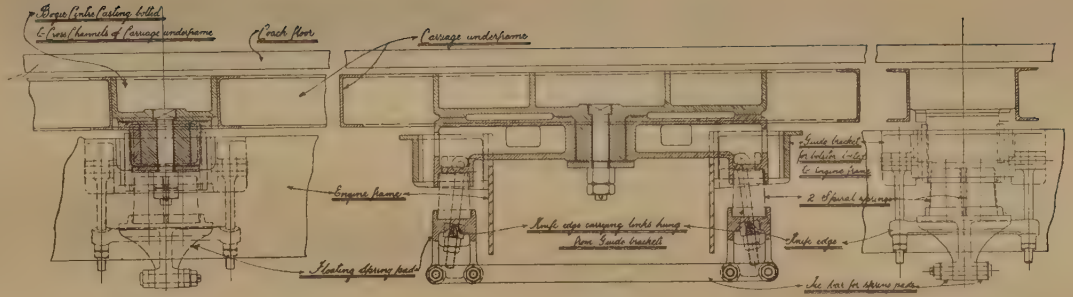
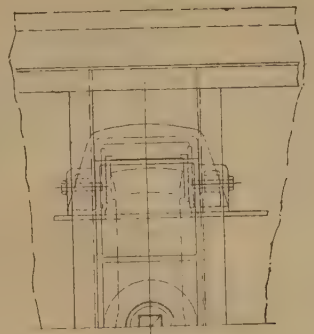


Fig. 2. — Furness Railway. — Steam motor engine.





Half plan.

Fig. 3. — London & North Western Railway. – Steam rail motor carriage. — Sketch showing method of attaching engine to carriage.

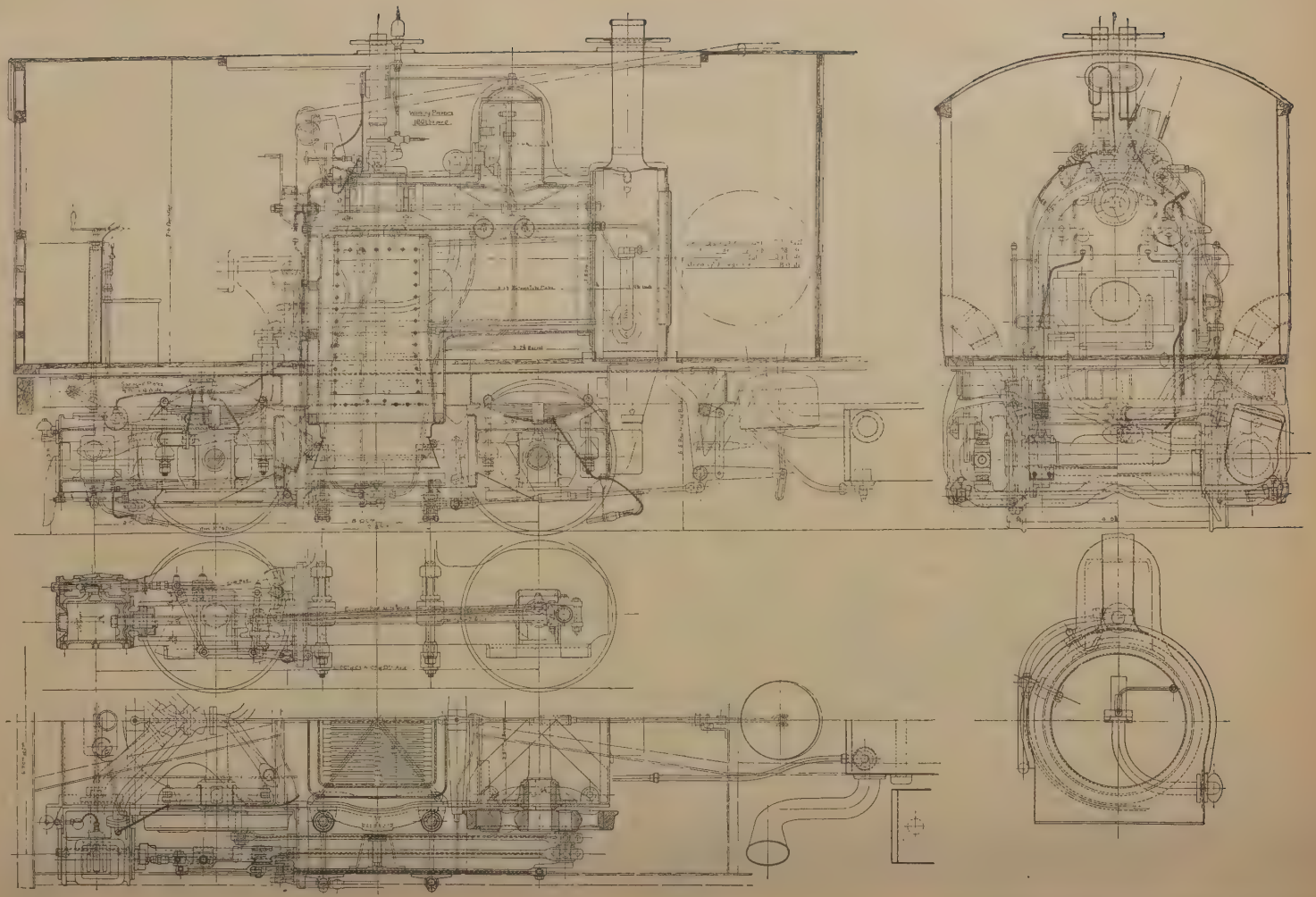


Fig. 4. — Midland Railway. — General arrangement of motor. — Steam motor carriage.

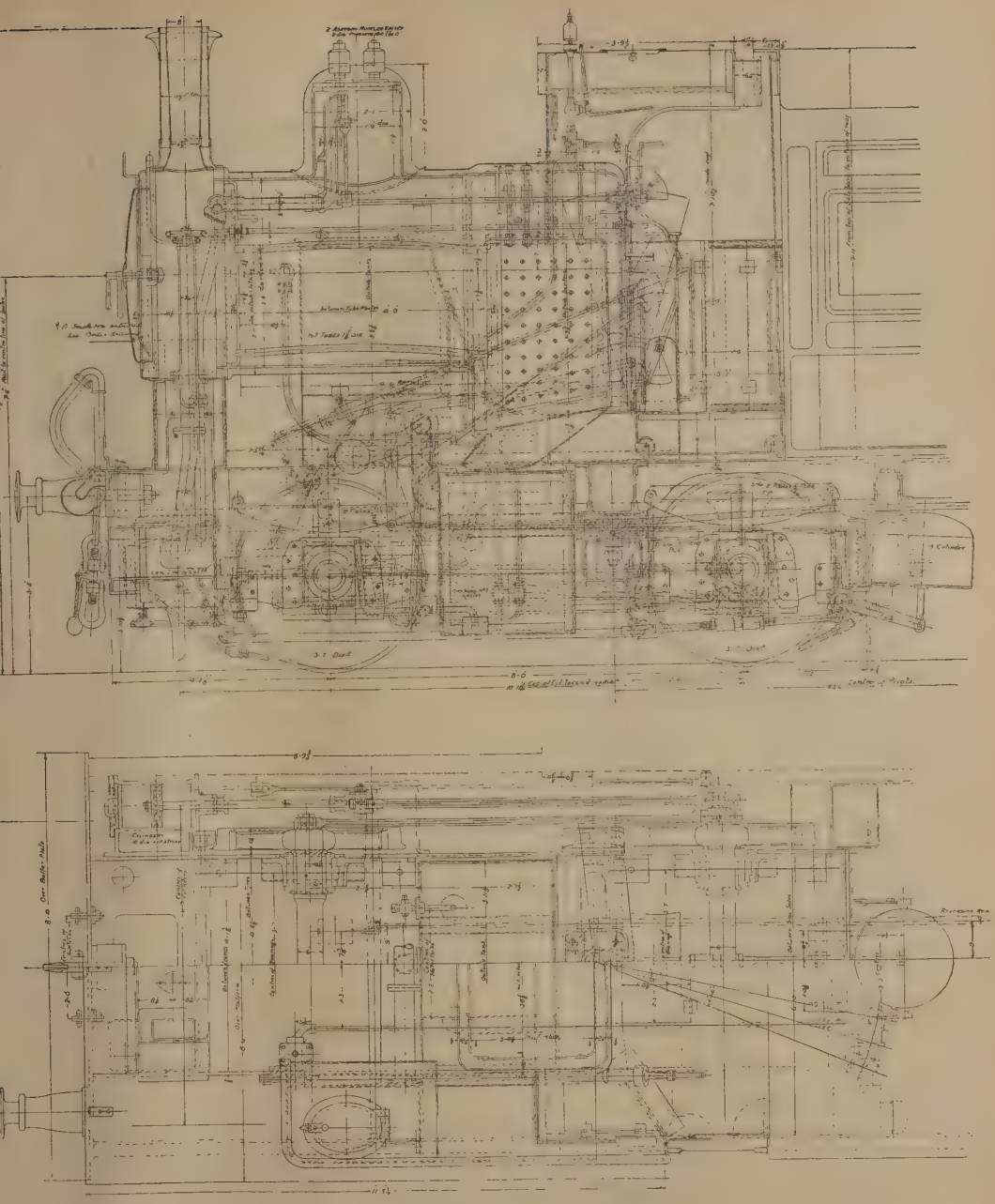


Fig. 5. — South Eastern & Chatham Railway.

Heating surface of tubes	337·0 square feet.	Grate area	8·8 square fee
— — of firebox	44·5 — —	Gauge of railway	4 ft. 8 1/2 in.
Total.	381·5 square feet.	Water	400 gallons.
		Coal	15 cw

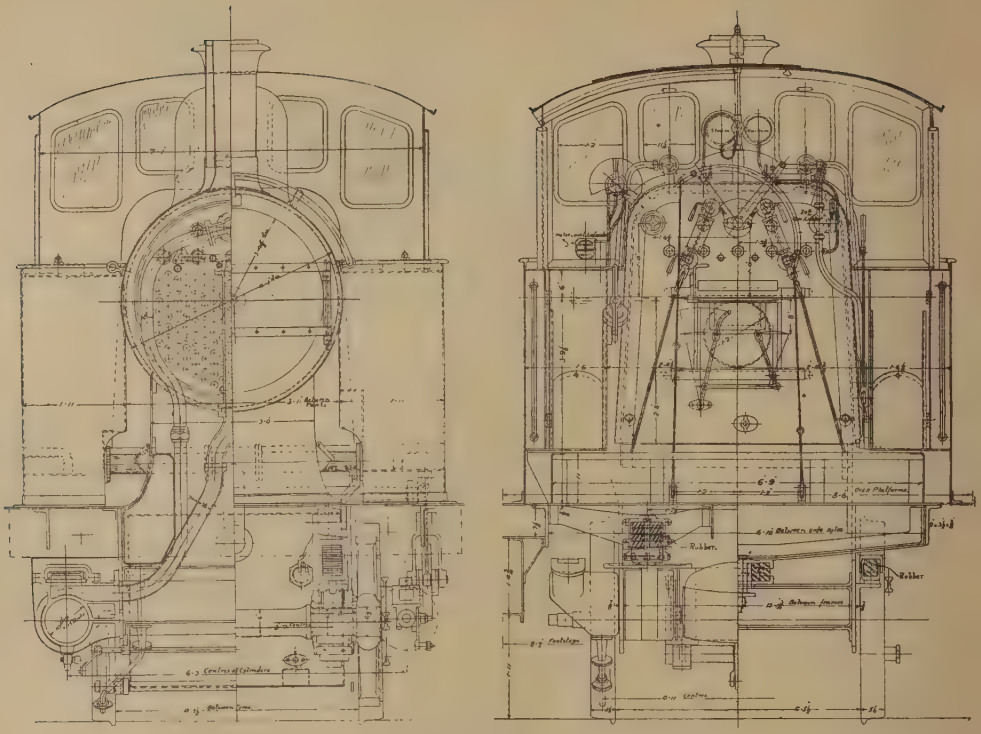


Fig. 6. — South Eastern & Chatham Railway. — Engine, steam motor coach.

Midland Railway. — Class 1 : Auto steam car. Combined engine and car. Class 2 : Pullman car with separate locomotive. Class 3 : " Short motor train ".

North Staffordshire Railway. — Ordinary type. Combined engine and car.

North Eastern Railway. — Petrol electric driven rail auto-cars. Petrol engine driving electric generator. " Short motor train ". (See appendix II.)

Port Talbot Railway. — Ordinary type. Combined engine and car.

Rhymney Railway. — Ordinary type. Combined engine and car.

South Eastern & Chatham Railway. — Ordinary type. Combined engine and car. Also " short motor trains ".

Taff Vale Railway. — Ordinary type. Combined engine and car. Also " short motor trains ".

Dublin & South Eastern Railway (Ireland). — " Short motor train " type only.

Great Northern Railway (Ireland). — " Short motor train " type only.

Central South African Railways. — Class 1 : Ordinary type. Combined engine and car. Class 2 : Small locomotive coupled by a " Gould " coupler to an ordinary coach.

South Australian Government Railways. — Ordinary type. Combined engine and car.

Great Indian Peninsula Railway. — Ordinary type. Combined engine and car.

Madras & Southern Mahratta Railway. — Ordinary type. Combined engine and car.

North Western State Railway of India. — Ordinary type. Combined engine and car.

QUESTION 2. — *Design of the automotor-car (elevation and plan), preferably to the scale of 3/4 inch to one foot.*

Please also show on plan : Driving axles ; coupled axles ; gauge of track ; section of rail ; distances from centre to centre of the axles and of bogies ; diameters of wheels respectively ; length over buffers ; length over body ; width over body ; width and the inner height of compartments ; maximum height from rail.

QUESTION 3. — *General design, with sections, of the motor, of the boiler (if any), and accessories, preferably to the scale of 3/4 inch to one foot.*

It would be advisable to have, apart from above, the most characteristic details of construction.

For automotors consisting of an independent engine, or else of an almost independent motor-truck, and of a car fastened to said engine, or else carried on one end by the underframe and on the other end by an axle or an ordinary bogie, please show how the car is joined to the engine.

RAILWAYS.	QUESTIONS									
	2 and 3		4		5	6				
						Class and number of seats.				
	Design.	*Weight.*	*Length of rail.*	*Number of sleepers to each rail.*	*Weight of ordinary carriage same capacity as motor cars.*	First.	Second.	Third.	Total.	*Luggage.*
Alexandra (Newport) Docks & Railway	Fig. 7.	36, 39, 40, 43 tons respectively.	30 feet	12	...	(*a*) ...	...	52	52	...
						(*b*) ...	...	58	58	...
Furness Railway	Fig. 25.	43 t. 7 c.	...	...	17 tons	12	...	36	48	...
Great Central Railway	Fig. 8.	44 t. 7 c.	30 or 45 feet	2 ft. 10 1/2 in. pitch	26 tons	←		...		→
Great Western Railway	Figs. 12-13.	←	...	→	33 t. 10 c.	←		...		→
Lancashire & Yorkshire Railway	Fig. 14.	47 t. 10 c.	30 feet	11	21 t. 5 c.	...	...	56	56	340 cubic feet.
London & North Western Railway	Fig. 15.	43 t. 8 c.	30 and 60 feet	12 and 24	20 t. 0 c.	...	...	48	48	...
London, Brighton & South Coast Railway	...	←	...	→	26 t. 10 c.	Class 1 :	...	60	60	598 cubic feet.
						Class 2 :	...	40 / 48	40 / 48	33 square feet.
						Class 3 :	...	48	48	32 square feet.
Midland Railway	Fig. 26.	←	...	→	17 t. 10 c	Class 1 :	...	64	64	...
						Class 2 : 6...	...	46	52	...
						Class 3 : 12..	...	80	92	...
North Staffordshire Railway	Fig. 20.	←	...	→	16 t. 10 c.	...	...	40	40	...
North Eastern Railway	Fig. 22.	34 t. 15 1/2 c.	...	...	23 t. 10 c.	...	...	52	52	Nil.
Port Talbot Railway	Fig. 23.	47 t. 2 c.	...	...	25 t. 0 c.	..	...	58	58	...
Rhymney Railway	Fig. 24.	...	30 feet	11	25 t. 0 c.	←		...		→
South Eastern & Chatham Railway	Fig. 16.	41 t. 5 c.	...	...	19 t. 14 c.	...	...	56	56	7 ft. x 6 ft. 6 in.
Taff Vale Railway	Figs. 29 & 30.	35 t. 14 c. / 44 t. 11 c.	45 feet	18	15 to 20 tons	(*a*) 12	...	40	52	...
						(*b*) 16	...	57	73	
Dublin & South Eastern Railway	Fig. 34.	46 tons	30 feet	10	25 tons	←	Fig. 34.			→ 2 tons.
Great Northern Railway (Ireland)	Figs. 35 & 36.	←	Fig. 35.	→	23 tons	←		...		→
Central South African Railways	...	44 t. 15 c. / 47 t. 10 c.	...	...	...	28	24	...	52	32·5 sq. ft.
						...	48	...	48	35·5 sq. ft.
South Australian Government Railways	Fig. 40.	20 t. 1 c.	...	...	12 t. 10 c.	9	13	...	22	Nil.
Great Indian Peninsula Railway	...	27 t. 0 c	...	...	30 t. 0 c.	8	...	54	62	Ditto.
Madras & Southern Mahratta Railway	Fig. 37.	38 t. 11 c.	30 feet	11	11 t. 10 c.	...	14	70	84	Ditto.
North Western State Railway of India	Fig. 39.	...	←	→	24 t. 0 c.	←		...		→

Figs. 7 to 11. — Steam motor cars British railways.

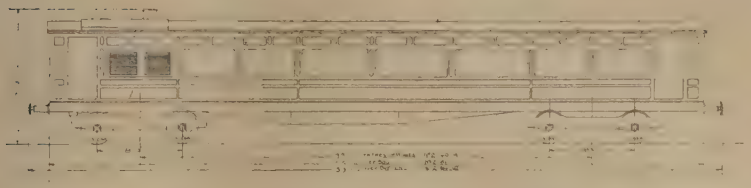


Fig. 7. — Alexandra (Newport) Docks & Railway.

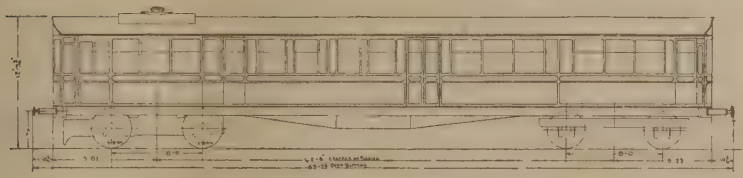


Fig. 8. — Great Central Railway.

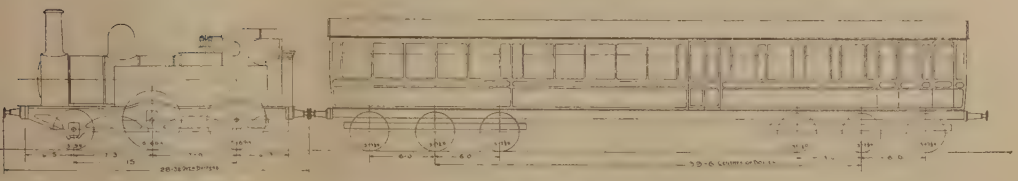


Fig. 9. — Great Central Railway No. 4.

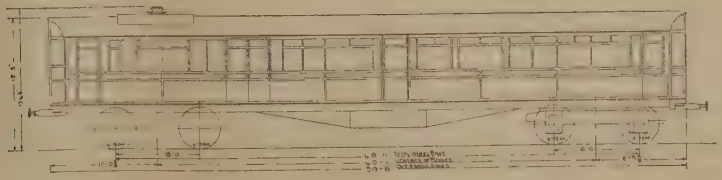


Fig. 10. — Great Western Railway.

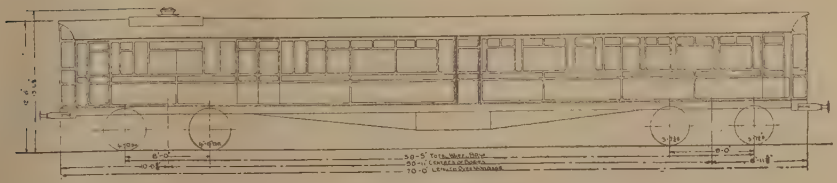


Fig. 11. — Great Western Railway. Branch type.

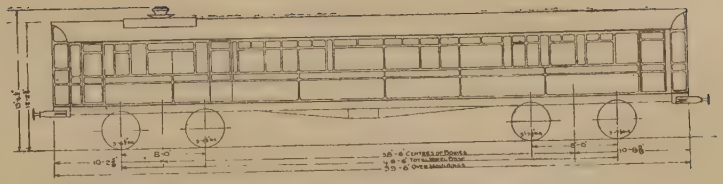


Fig. 12. — Great Western Railway. — Suburban type.

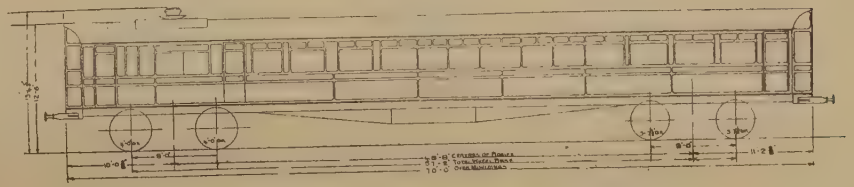


Fig. 13. — Great Western Railway. — Suburban type.

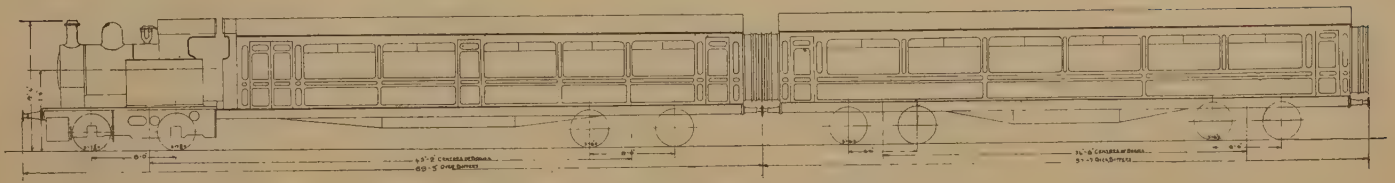


Fig. 14. — Lancashire & Yorkshire Railway.

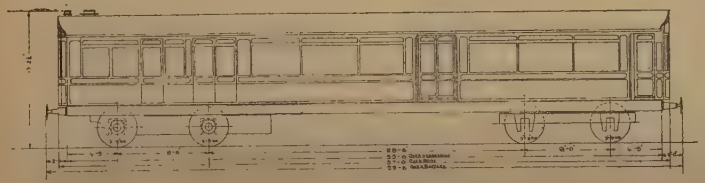


Fig. 15. — London & North Western Railway.

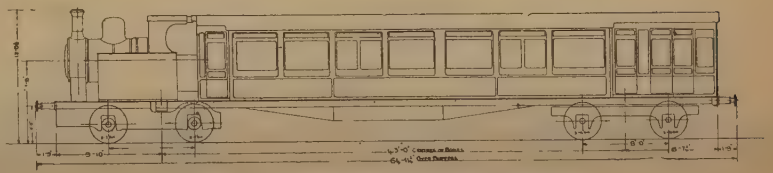


Fig. 16. — South Eastern & Chatham Railway.

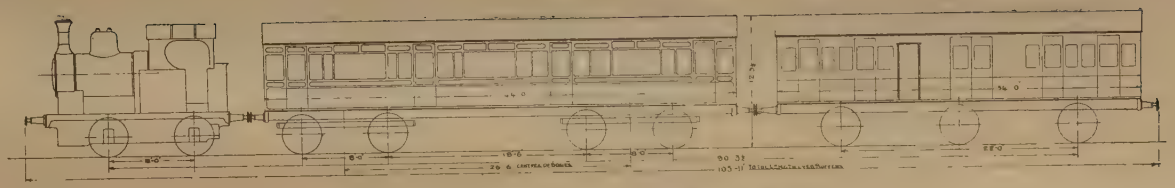


Fig. 17. — Dublin & South Eastern Railway.

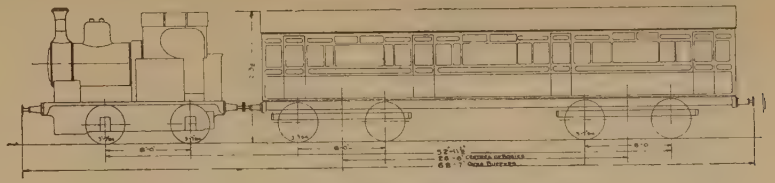


Fig. 18. — Dublin & South Eastern Railway.

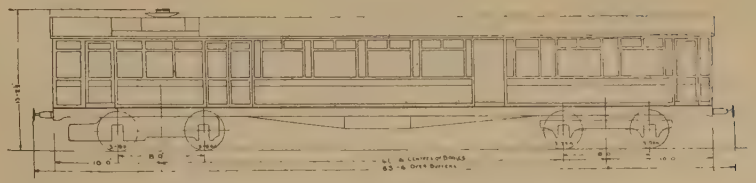


Fig. 19. — Great Northern Railway (Ireland).

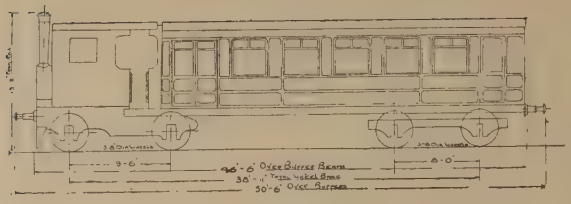


Fig. 20. — North Staffordshire Railway.

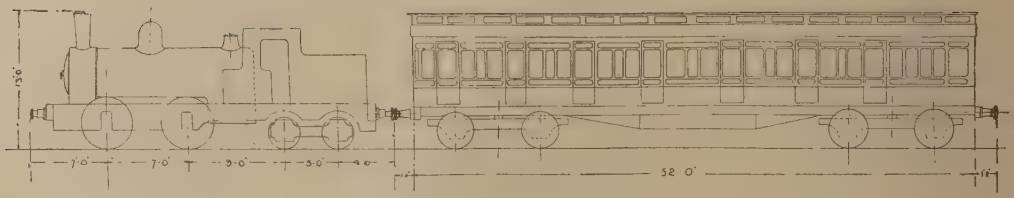


Fig. 21. — North Eastern Railway.

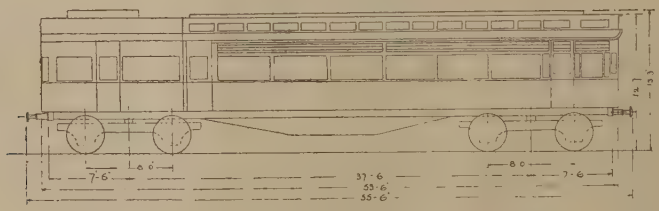


Fig. 22. — North Eastern Railway. — Electric autocar.

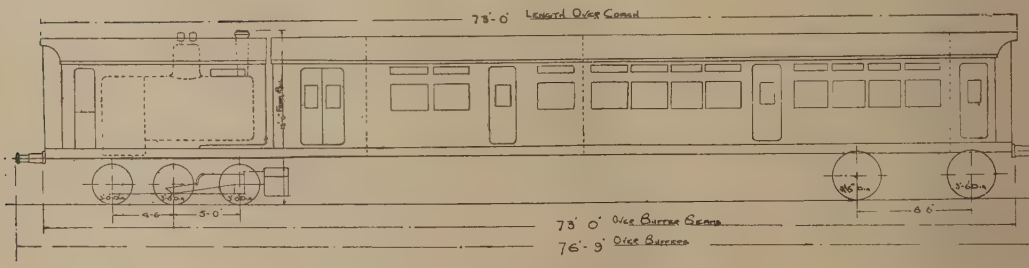


Fig. 23. — Port Talbot Railway and Docks Cy.

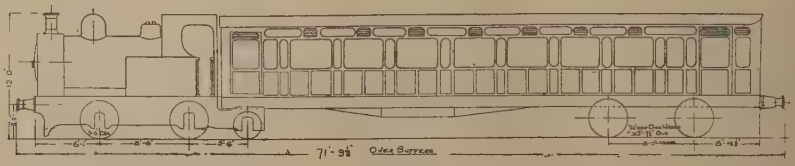


Fig. 24. — Rhymney Railway.

Fig. 25. — Furness Railway.

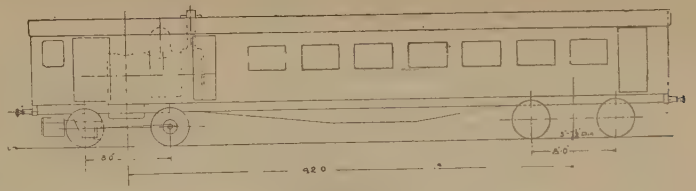


Fig. 26. — Midland Railway Company.

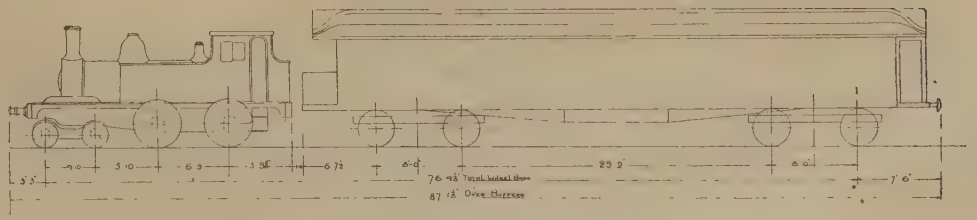


Fig. 27. — Midland Railway.

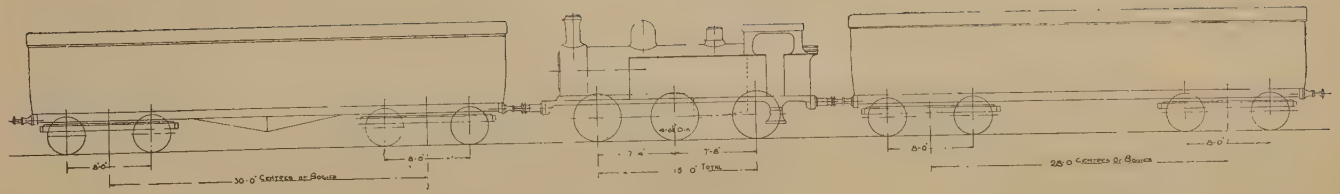


Fig. 28. — Midland Railway.

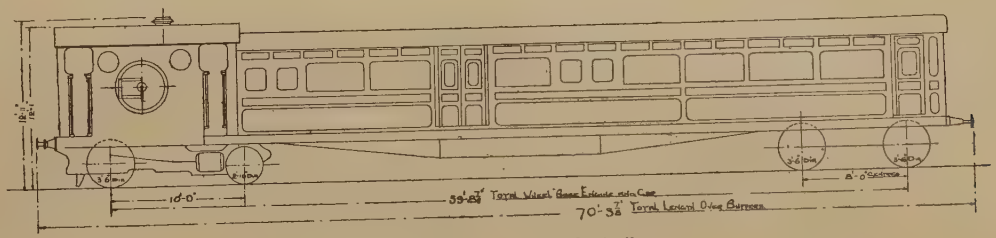


Fig. 29. — Taff Vale Railway.

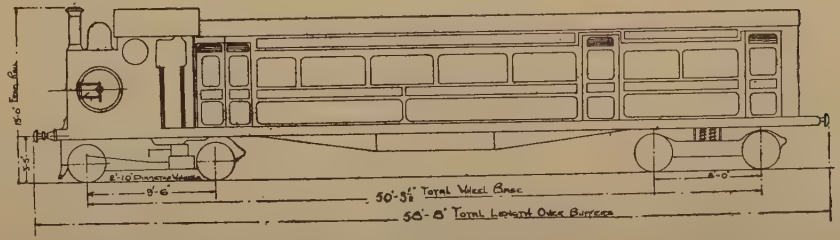


Fig. 30. — Taff Vale Railway.

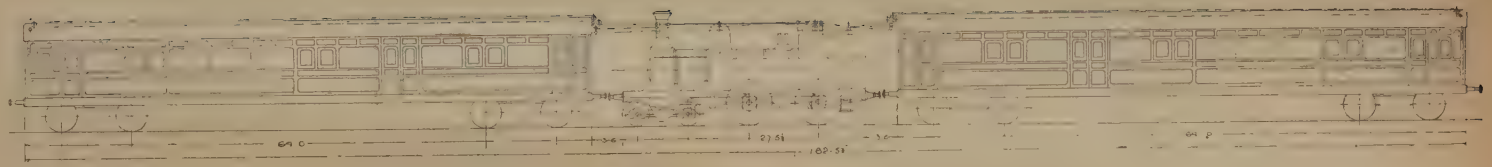


Fig. 31. — Taff Vale Railway.

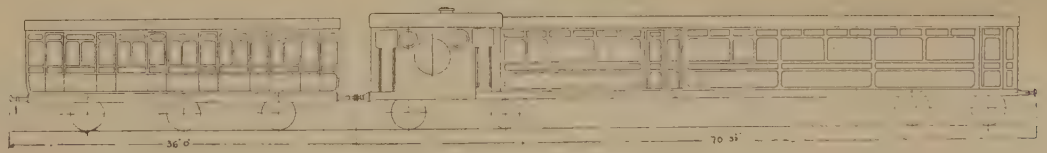


Fig. 32. — Taff Vale Railway.

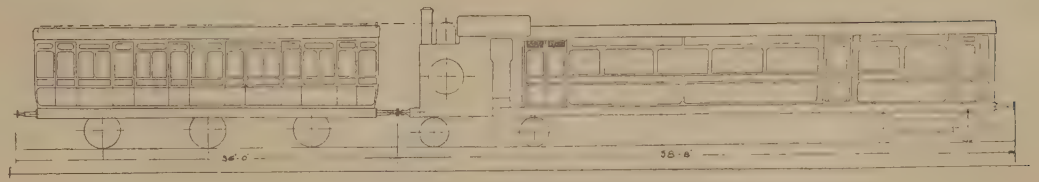


Fig. 33. — Taff Vale Railway.

RAILWAYS.	Question 7. — *Brake-gear*		Question 8. — *Heating and Lighting*	
	Description.	How acts.	Heating.	Lighting.
Alexandra (Newport) Docks & Railway Company	Steam and Screw.	Steam acts on 4 wheels at boiler end. Screw acts on all wheels.	Live steam.	Acetylene gas and electricity Outside lamps oil.
Furness Railway	Automatic Vacuum.	On all wheels.	Ditto.	Electric; outside lamps oil.
Great Central Railway	Automatic Vacuum and Screw.	On all wheels except leading wheels of independent engine.	« Gould's » steam.	Stones electric.
Great Western Railway	Ditto.	On all wheels.	Steam.	Incandescent oil gas. Petroleum, front and end lamps.
Lancashire & Yorkshire Railway	Ditto.	On all wheels. Separate screw brakes for engine and coach bogies to act as a stand by.	Gould's heaters.	Incandescent gas Footplate, front and tail lamps-oil
London & North Western Railway	Automatic Vacuum and hand.	On all wheels.	Steam.	Electric.: Front und tail lamps oil.
London, Brighton & South Coast Railway.	Westinghouse and hand	Ditto.	Nil.	Stones' electric.
Midland Railway	Class 1 : Vacuum.	Ditto.	Footwarmers.	Gas.
	Class 2 : Vacuum and steam.	Steam brake on engine. All wheels braked except engine bogie. All wheels on Pullman car-vacuum brake.	Ditto.	Gas. Drivers cab and outside lamps oil.
	Class 3 : Ditto.	Steam brake on engine. Vacuum brake on coaches.	Steam.	Gas.
North Staffordshire Railway	Automatic Vacuum.	Acts on all wheels.	Steam (Laycocks).	Electricity. Petroleum outside lamps.
North Eastern Railway.	Hand brake and Electro-Magnetic Track Brake.	Hand brake on one bogie only. Magnetic brake on both bogie wheels.	By radiator pipes of petrol engine.	Electricity.
Port Talbot Railway	Hand, Steam and Vacuum.	Hand brake at either end. Steam brake on engine wheels only. Vacuum on all wheels.	Gould's system.	Ditto.
Rhymney Railway.	Westinghouse and hand.	Westinghouse on all wheels excepting engine trailer wheels. Hand on engine leading and driving wheels and car bogie wheels.	Footwarmers.	Stones electric. Leading end of engine oil lamps.
South Eastern & Chatham Railway	Automatic Vacuum and Screw.	On all wheels.	Footwarmers.	Stones' Electric. Front and tail lamps oil.
Taff Vale Railway	Automatic Vacuum Steam and hand brake.	Ditto.	Steam. G. D. Peeters system.	Incandescent oil gas. Oil lamp for drivers cab und outside lamps.
Dublin & South Easter Railway	Automatic Vacuum.	Ditto.	Steam.	Incandescent gas. Head tail and side lamps oil.
Great Northern Railway Ireland)	Automatic Vacuum and hand brake.	Ditto.	Steam. Gould's system.	Stone's electric.
Central South African Railways.	Automatic Vacuum and hand brake.	On drinving pair of wheels only of locomotive and all wheels of coach bogies.	Steam. Laycocks system.	Ditto.
South Australian Railways	Westinghouse and hand.	All wheels.	Nil.	Stone's electric for car. Head and tail lamps oil.
Great Indian Peninsula Railway	Automatic and hand.	Dito.	Nil.	Electric.
Madras & Southern Mahratta Railway	Vacuum and hand.	Ditto.	Nil.	Gas inside car and outside car lamps. Outside lamps on engine oil.
North Western State Railway of India.	Vacuum Screw and Steam.	Vacuum on trailing end only. Screw on both bogies. Steam-engine end only.	Nil.	Gas and oil lamps.

QUESTION 9. — *Buffing Gear.*

Alexandra (Newport) Docks & Railway Company. — Normal type.

Furness Railway. — Normal type.

Great Central Railway. — Ordinary buffers of standard type.

Great Western Railway. — Standard buffing gear on ordinary cars. Central buffers when trailer is permanently attached.

Lancashire & Yorkshire Railway. — Normal type both ends.

London & North Western Railway. — Normal type with springs.

London Brighton & South Coast Railway. — Normal type.

Midland Railway. — Class 1 : Ordinary buffing gear. — Class 2 : Ordinary gear on car and front of engine. Solid beam at rear of engine. — Class 3 : Ordinary buffing gear.

North Staffordshire Railway. — Normal type.

North Eastern Railway. — Normal type.

Port Talbot Railway. — Normal type.

Rhymney Railway. — Normal type self contained.

South Eastern & Chatham Railway. — Buffing gear ordinary socket buffers on engine and car.

Taff Vale Railway. — Ordinary type.

Dublin & South Eastern Railway (Ireland). — Ordinary type.

Great Northern Railway (Ireland). — Ordinary type.

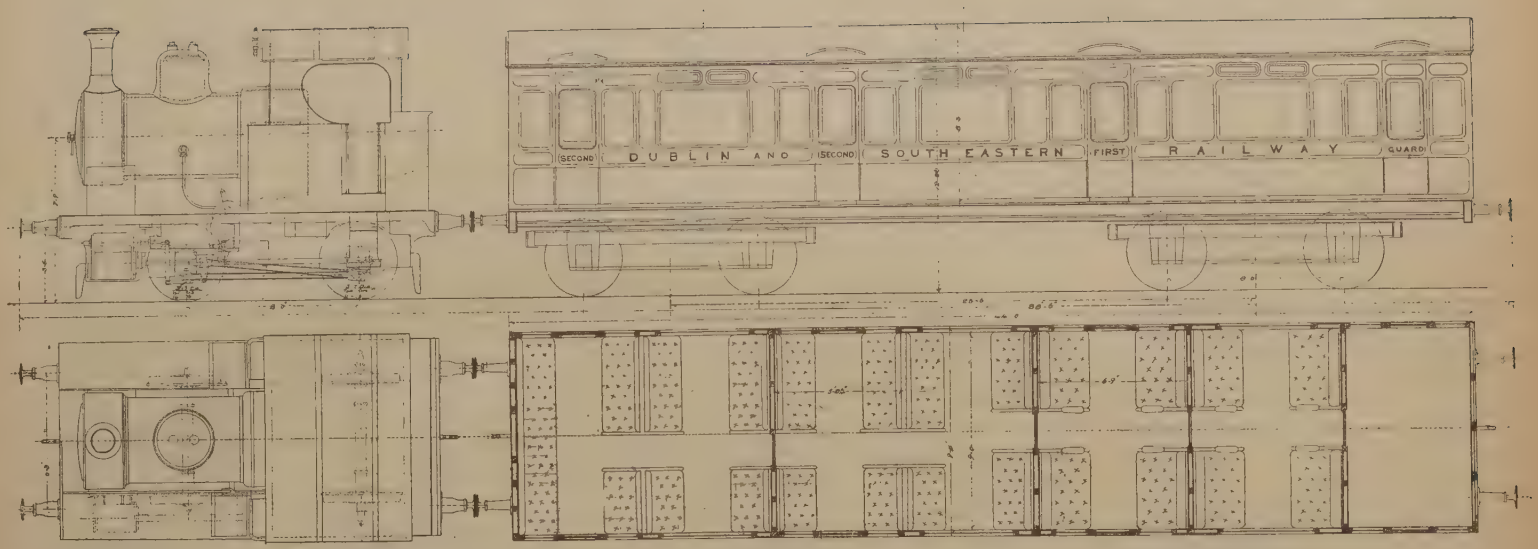
Central South African Railways. — Class 1 : Gould coupler between engine and coach Standard pattern for new coaching stock. — Class 2 : Central buffers (Cape pattern) being standard for all wagon stock.

South Australian Government Railways. — Normal type.

Great Indian Peninsula Railway. — Normal type of compensating buffer gear.

Madras & Southern Mahratta Railway. — Normal type.

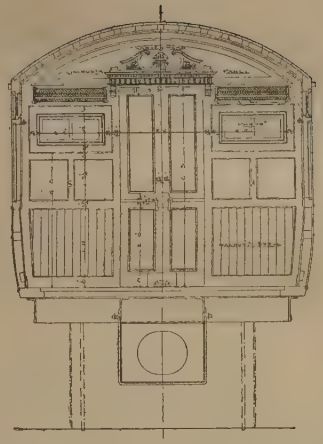
North Western State Railway of India. — Standard gear.



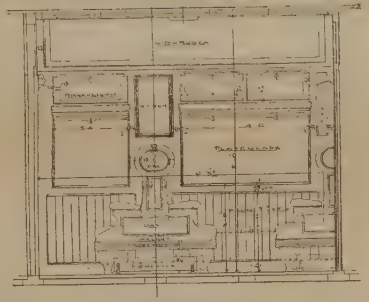
Cylinders	12 × 16 inches.
Gauge of railway	5 ft. 3 in.
Water	540 gallons.
Coal	1 1/4 tons.

Boiler pressure	175 lb. per square inch.
Heating surface in fire-box	45 square feet.
— — in tubes	441 — —
Total	486 square feet.
Grate area	9·5 square feet.

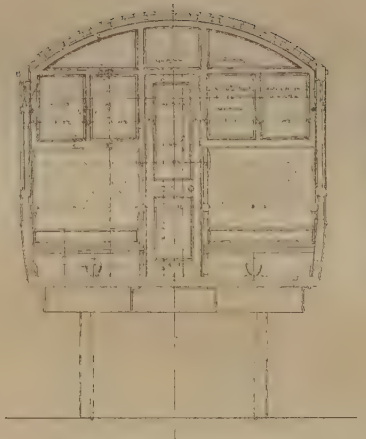
Fig. 34. — Dublin and South Eastern Railway. — Motor train.



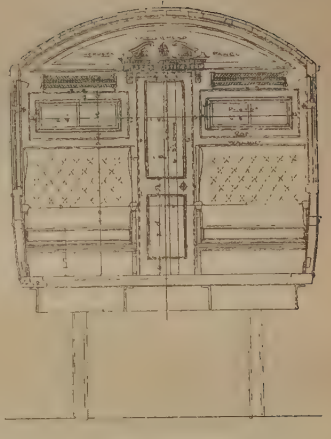
End of first class at vestibule.



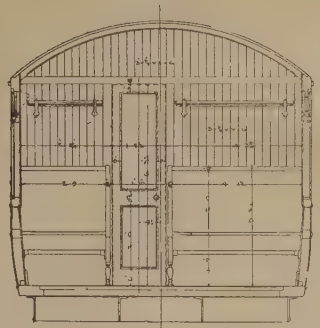
Section first class.



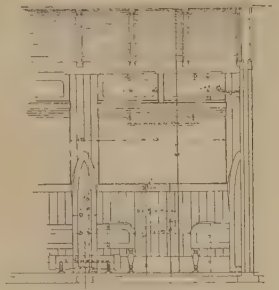
Class partition in first class.



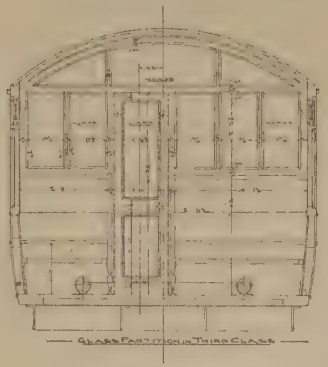
End of first class.



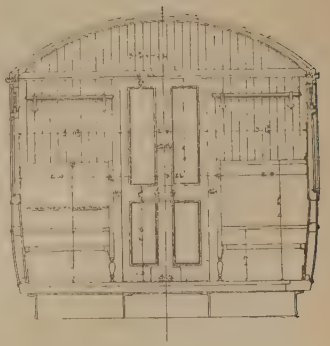
End of third class at luggage.



Section third class.

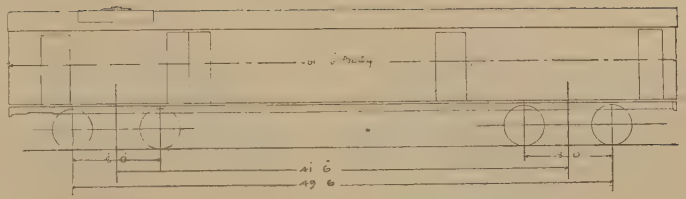


Class partition in third class.



End of third class at vestibule.

Fig. 36. — Great Northern Railway (Ireland). — 61 ft. 6 in. car class B. — Sections of steam rail motor car.



Engine bogie.

28 tons 10 cwts.
30 — 0 —

Carriage bogie.

16 tons 10 cwts. in working order 45 tons 0 cwts. Total.
19 — 0 — { with passengers and luggage } 49 — 0 — —

Fig. 35. — Great Northern Railway (Ireland) — Diagram of weights and wheelbase.
Steam rail motor cars class B.

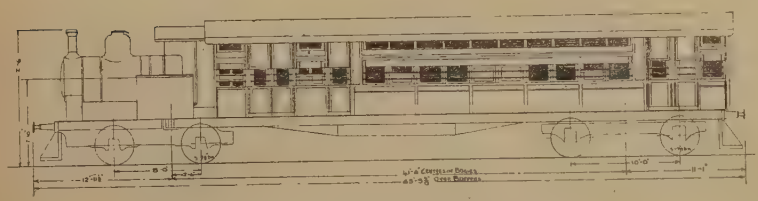


Fig. 37. — Madras & Southern Mahratta Railway.

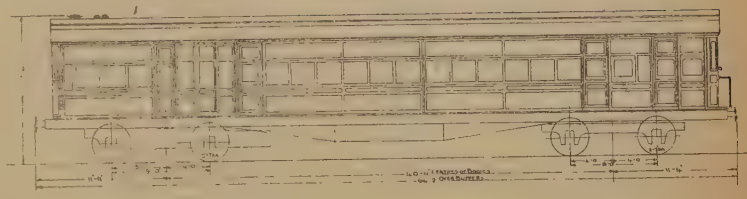


Fig. 38. — East Indian Railway.

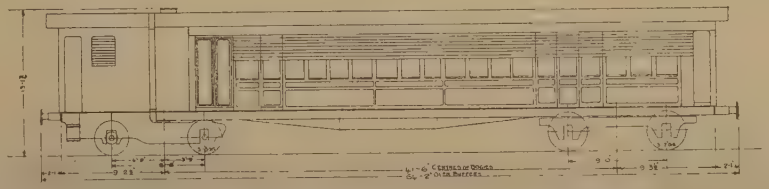


Fig. 39. — North Western Railway (India). — Steam motor cars.

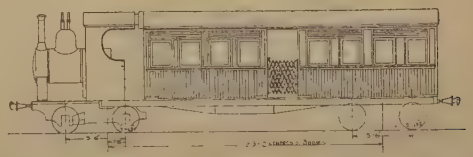


Fig. 40. — South Australian Railway. — 3 ft. 6 in. gauge.

RAILWAY.	Question 10. — *Boiler.*						
	Type.	Grate area, in square feet	Tubes.			Heating surface, in square feet.	
			Number.	Length.	Inner diameter.	Tubes.	Fire-box.
Alexandra (Newport) Docks & Railway	Locomotive type with water tubes in fire-box.	7	Smoke, 155 Water, 119	2 ft. 6 in.	1 5/16 inches.	Smoke, 152 Water, 119	76
Furness Railway	Locomotive.	12	Smoke, 226	...	1 3/4 inches external.	Smoke, 438.4	71
Great Central Railway	...						
Great Western Railway	Vertical cone top.	...					
Lancashire & Yorkshire Railway	Locomotive.	9·4	199	5 ft. 0 in.	1.54 inches.	455	54
London & North Western Railway	Drawings.						
London Brighton & South Coast Railway — Class 1.	Ordinary locomotive.	10	121	8 ft. 2 3/4 in.	1 9/16 inches.	463	55
London Brighton & South Coast Railway — Class 2.	Special locomotive, Belpaire-box.	7	242	3 ft. 11 in.	1 3/16 inches.	327·4	41·6
Midland Railway — Class 1.	Locomotive type.	8·9	182	3 ft. 11 1/2 in.	1 1/2 inches 11-13 WG external.	291	58
Midland Railway — Class 2.	Ditto.	11·3	190	9 ft. 2 5/8 in.	1 5/8 inches 11-14 WG external.	754 52	67·23
Midland Railway — Class 3.	Ditto.	14·8	213	10 ft. 4 5/8 in.	1 3/4 inches 11-14 WG external.	1,024	91
North Staffordshire Railway	Locomotive type.	7	242	3 ft. 11 in.	1 3/8 inches 14 WG external.	328	40
North Eastern Railway	No rail *auto steam* cars. — (See separate statement supplied.)						
Port Talbot Railway	Locomotive type 170 lb. pressure.	13·1	...	...	...	591	69
Rhymney Railway	Locomotive type.	...					
South Eastern & Chatham Railway	Ditto.	8·8	167	4 ft. 9 in.	1 3/8 inches.	337	445
Taff Vale Railway	Locomotive type double ended.	8	299	2 ft. 3 3/16 in.	1 17/32 inches.	292·28	21·28
	Ditto.	10·2	464	2 ft. 3 3/16 in.	1 13/32 inches.	414·21	22·71
Dublin & South Eastern Railway	...						
Great Northern Railway (Ireland)	...						
Central South African Railways — Class 1.	Locomotive type	7·2	95	8 ft. 11 in.	1 5/8 inches.	425	Total including fire-box
Central South African Railways — Class 2.	Ditto.	10·75	180	6 ft. 0 in.	1 3/8 inches.	459·5	50·5
South Australian Government Railways	Ditto.	4·9	...	...	...	117 4	30
Great Indian Peninsula Railway	...						
Madras & Southern Mahratta Railway	Locomotive type.	9·76	174	6 ft. 0 in.	1 5/8 inches 11 WG external.	444·15	46·19
North Western State Railway of India	Ditto.	9	164	3 ft. 6 in.	1 3/4 inches external.	252	48

RAILWAYS.	QUESTION 10. (Continued.) — Number and type of feeding apparatus.	Safety spring.
Alexandra (Newport) Docks & Railway.	No. 1 car 2 injectors. No. 2 car 2 steam inspirators.	Double spring.
Furness Railway	Two No. 5 injectors.	Ramsbottom.
Great Central Railway.	...	...
Great Western Railway	Two No. 6 injectors.	2 « Pop ».
Lancashire & Yorkshire Railway	2 Gresham and Craven type No. 8 injectors.	One twin Ramsbottom 3 inches diameter.
London & North Western Railway	2 Gresham No. 5 combination injectors.	One duplex spring safety valve.
London Brighton & South Coast Railway — Class 1.	2 C' head pumps.	2 spring balanced 2 1/2 inches diameter.
London Brighton & South Coast Railway — Class 2.	2 No. 7 Combination injectors.	Ramsbottom 2 1/4 inches.
London Brighton & South Coast Railway — Class 3 and 4.	...	...
Midland Railway. — Class 1.	Injectors.	Spring loaded.
Midland Railway. — Class 2.	Ditto.	Ditto.
Midland Railway. — Class 3.	Ditto.	Ditto.
North Staffordshire Railway.	2 Gresham and Graven's No. 7 combination injectors.	Ramsbottom 2 2 1/4 inches.
North Eastern Railway	...	...
Port Talbot Railway.	Two 6 Millimeter Gresham and Craven.	Crosby's « Pop ».
Rhymney Railway	2 injectors.	...
South Eastern & Chatham Railway	Ditto.	« Pop ».
Taff Vale Railway	2 Gresham and Craven's.	Ramsbottom.
Dublin & South Eastern Railway	←	
Great Northern Railway. (Ireland)	Two No. 6 Gresham and Craven.	Crosby's « Pop » 2 1/2 inches.
Central South African Railways. — Class 1.	Two injectors.	Two.
Central South African Railways. — Class 2.	Ditto.	Ditto.
South Australian Government Railways.	Two Gresham & Craven.	Two Ramsbottom.
Great Indian Peninsula Railway	Two No. 5 Gresham and Craven.	Two spring safety valves 2 inches.
Madras & Southern Mahratta Railway	Ditto.	Ramsbottom.
North Western State Railway of India	...	...

rheating apparatus not used. No liquid fuel used.

Blower.	Blast pipe.	Pressure.	Coal used.	Cylinders.	Motion.
...	Fixed blast nozzle 1 5/8 inch diameter.	160 lb. per square inch.	Lumps.	Two 9 × 14 inches simple expansion.	...
...	Fixed 3 inches.	160 lb.	Yorkshire.	Two 11 × 14 inches simple expansion.	Walschaerts valve gear.
...	...	...	Lumps.	...	..
...	Fixed 3 1/2 inches.	160 lb.	Lumps, small and mixed.	...	...
ne annular jet type.	Fixed.	180 lb.	Lumps.	Two 12 × 16 inches.	Walschaerts gear.
steam blower.	Fixed 3 inches.	175 lb.	Lumps.	...	...
Ring.	Fixed 3 3/4 inches.	150 lb.	Welsh and Shipley.	Two 12 × 20 inches simple expansion.	Link six-coupled engine ordinary connecting rod distribution.
Ring.	Fixed 2 5/8 inches.	180 lb.	Ditto.	Two 8 1/2 × 14 inches.	Walschaerts single D.W. engine ordinary connecting rod distribution.
...	...	...	Pratt's spirit.	...	..
Ring.	Fixed 2 1/4 inches.	160 lb.	Lumps.	Two 11 × 15 inches simple expansion.	Walschaerts.
Ditto.	Fixed 4 1/4 inches.	140 lb.	Ditto.	15 × 20 inches.	Stephenson Link.
Ditto.	Fixed 4 6/8 inches.	140 lb.	Ditto.	17 × 24 inches.	Ditto.
Ditto.	Fixed 2 5/8 inches.	180 lb.	Ditto.	Two 8 1/2 × 14 inches.	Walschaerts.
...	...	...	...	...	
Ring.	Jones' Patent fixed.	170 lb.	Welsh.	Two 12 × 16 inches.	Walschaerts.
...	Fixed.	175 lb.	Ditto.	← ... →	
Ring.	Fixed some « high » 2 1/2 inches some « low » 2 3/4 inches.	160 lb.	Bituminous Small with large proportion of dust.	Two 10 × 15 inches.	Walschaerts.
m blower pipe.	Fixed.	Large car 180 lb.; Small car 160 lb.	Welsh.	10 1/2 × 14 inches Large car 9 × 14 inches Small car.	...
	...				
Ordinary.	Ordinary.	175 lb.	Welsh.	Two 12 × 16 inches.	...
One blower.	Ordinary 2 3/4 inches.	160 lb.	Lump.	Two 11 × 21 6/8 inches.	« Allan » straight link.
Ditto.	Ordinary 2 3/4 inches.	160 lb.	Ditto.	Two 11 × 16 inches.	Walschaerts.
Ring.	Fixed.	180 lb.	Lumpy bituminous.	Two 6 1/2 × 10 inches.	Ditto.
Ditto.	Fixed 2 1/4 inches.	170 lb.	Indian lumps.	← Two. →	
One blower.	Fixed 3 1/4 inches.	160 lb.	Ditto.	...	...
...	...	...	...	...	...

QUESTION **11**. — *Relating to explosion automotor cars.*

London, Brighton & South Coast Railway. — Class 3 : Two 4-cylinder motors, cylinder 124 millimetre (4 $^{7}/_{8}$ inches) diameter by 150 millimetres (5 $^{15}/_{16}$ inches) stroke. Ignition by accumulator dryving one axle by friction clutch and spur gearing. — Class 4 : One 4-cylinder motor. Cylinders 180 millimetres (7 $^{1}/_{16}$ inches) diameter by 150 millimetres (5 $^{15}/_{16}$ inches) stroke. Drives dynamo through magnetic clutch which is automatically released at a certain voltage. The dynamo charges accumulators and when the potential is reached, the dynamo becomes motor and drives one axle through spur gearing.

North Eastern Railway. — See separate description appended (appendix II).

None of the other railways dealt with have these cars running.

QUESTION **12**. — *Relating to cab arrangements for driving from either end, according to whether the engine or car end is leading.*

Alexandra (Newport) Docks & Railway Company. — Cab at each end for driver. The auxiliary cab is fitted with an arrangement for reversing and is also connected to the regulator valve by means of levers and rods which can be opened and closed. Intercommunication with the cab of the engine by means of electric ringing.

Furness Railway. — Two similar cabs with outfits at each end. Electric ringing used for intercommunication. Whistle and regulator coupled by means of wire rope. Guard controls valve for use of brake.

Great Central Railway. — Electric bell and speaking tube communication. Steam whistle operated by wire cord. Regulator operated by rod and universal joints for both closing and opening. Screw brake on all wheels of coach only, vacuum brake on all wheels including engine. Reversing gear of engine. Sand gear on wheels of coach.

Great Western Railway. — Engine cab at one end and vestibule with regulator handle, hand brake lever, vacuum brake cock. Electric communication and whistle connection at other end.

Lancashire & Yorkshire Railway. — In addition to the cab on the engine, there is a driver's compartment at the rear end fitted with the following appliances — regulator handle which can open or shut off steam to the engine ; this handle has a spigot and socket connection, and it is so arranged that the driver must carry it with him when he goes to drive at the opposite end of the coach. Vacuum brake application valve which will operate the brakes on both the engine and coach bogie wheels. Screw gear to operate the coach bogie wheels only. Lever and cord arrangement for blowing the whistle on engine. Electric bell and switch for signalling purposes between engine cab and driver's compartment. Vacuum application valve for operating the steps. A vacuum gauge.

London & North Western Railway. — There is the compartment proper at the engine end and an auxiliary compartment at the opposite end of the car, from either of which the car can be driven in either direction. When driving from the auxiliary compartment, the driver has full control of the engine regulator, the automatic vacuum brake and the hand brake. In addition

he can communicate with the fireman in the engine cab by means of a code of electrical signals given on a gong.

London Brighton & South Coast Railway. — Class 1 : Ordinary tank engine covered cab compartment for driver at end of coach when running coach first. Compartment contains regulator handle, electric bell and push. Compressed air whistle lever, wire pull to engine whistle, drivers B. V. for Westinghouse brake and screw hand brake operating all wheels of trailer coach. Regulator works open and shut by universal coupling between engine and coach. — Class 2 : Cab covering all except smokebox and chimney. Compartment at end of coach for driver when running coach first. Compartment contains regulator handle electric bell and push. Compressed air whistle lever, wire pull to engine whistle, driver's B. V. for Westinghouse and screw hand brake operating all wheels of trailer coach. Regulator works open and shut by universal coupling between engine and coach.

Midland Railway. — Class 1 : Engine and cab at one end and cab at other end. — Class 2 : Cab at end of coach remote from engine. Both classes car travel backward at will.

System of operation. — Vacuum brake and whistle can be operated from both ends of train. The main steam regulator can be operated by wire ropes from cab for a supplementary regulator placed between ordinary regulator and cylinders. There is an electric signalling apparatus between driver and fireman for notching up and reversing purposes. — Class 3 : Cabs at ends of coaches remote from engine. Can travel backward at will. System of operation. Vacuum brake and whistle can be operated from both ends of train. There is a vacuum controlling gear.

North Staffordshire Railway. — One cab at engine end but when car is running backwards the fireman (who is a passed driver) stands in the vestibule at other end of car and there he is able to close the regulator, etc. In the vestibule at end of car used in running backwards as an auxiliary cab, levers are arranged for closing the regulator (not opening) and opening the steam whistle ; also there is a valve for applying the brakes and an electric bell for signals to the driver in engine cab.

North Eastern Railway. — Driver's cab at each end. Each cab provided with levers, brakes and controller for complete operation of the car. Engine under control of driver from either end. Whistle blown by compressed air, supplied from electrically driven air compressor.

Port Talbot Railway. — Fitted with sand boxes on the vestibule end. A complete engine at one end with an auxiliary cab at the other end occupied by driver when travelling backwards. The outfit of the auxiliary cab comprises regulator lever, vacuum ejector, hand brake, lever controlling sand gear whistles and electric bell. Signalling between driver and fireman is done by means of an electric bell.

Rhymney Railway. — Driver's cab on engine when travelling backwards the driver is in the car end. Intercommunication with the trailing end of car and engine, by means of electric bell ringing. The regulator can be worked from the rear end of car, also the continuous brake, hand brake (car only) and steam whistles.

South Eastern & Chatham Railway. — One cab on engine only. A luggage and driver's compartment at one end of car. The driver's compartment at one end of car is fitted with steam regulator closed and open, reversing gear, automatic vacuum brake application only. Screw brake on car bogie only. Steam whistle gear. The means of intercommunication with engine cab — a system of electric bell ringing is employed.

Taff Vale Railway. — The motor driver travels on foot-plate of engine together with the assistant motorman when running forward. For backward running driver stands in special compartment at end of coach and communicates with the assistant motorman by means of electric bells. The motor driver, when standing in this compartment has direct communication to the steam whistle on engine and also has control of a hand screw brake fitted therein. The regulator is opened and closed by the assistant motorman standing on the footplate of engine on receiving the signal from the motor driver.

Great Northern Railway (Ireland). — Electric bell communication Phaburn's mechanical telegraph for reversing twine cord for steam whistle. Regulator may be opened or closed and brake applied.

Central South African Railways. — The driver's compartment or auxiliary cab of these cars is fitted with gear for controlling the regulator, valve gear, brake, and apparatus for operating the engine steam whistle. Communication between the driver and conductor is provided for by a system of bell signals.

South Australian Government Railways. — No. 1 car has only one cab, No. 2 being fitted, with two. The auxiliary cab of No. 2 car is fitted with reversing gear and regulator handle. Communication is established by means of an electric bell. The driver also has control of the steam whistle. Air brake can be applied only.

Great Indian Peninsula Railway. — Cab on engine end, regulator handle, whistle handle and brake valve at end of car and on the engine. Electric bell code signals between driver and guard. In cases of emergency guard can close regulator and apply brakes.

Madras & Southern Mahratta Railway. — 1 cab engine and guard's compartment used by driver when running backwards regulator lever attached to regulator in guards oompartment by wire. See ferrotype No. 7660. Regulator handle, whistle cock, vacuum brake lever, vacuum gauge, hand brake and reversing gear. Intercommunication cord with whistle gear.

North Western State Railway of India. — Cab at engine end and cab at carriage end to enable car to be worked from either end. Complete controlling gear and speaking tubes.

QUESTIONS **13** AND **14**. — *a) Whether it is intended to adopt for local or light trains, specially designed small locomotives instead of automotor cars, with a view to attaining an economical service. If so please furnish particulars. — b) If not possessing specially designed small locomotives for such a service, please give particulars of locomotive of lightest type now in service.*

Alexandra (Newport) Docks & Railway. — *a)* Yes but have no designs.

Furness Railway. — *a)* No.

Great Central Railway. — *a)* No.

Great Western Railway. — *a)* We use small locomotives specially fitted with gear for driving from trailer cars attached at either or both ends of locomotive.

Lancashire & Yorkshire Railway. — *a*) No. — *b*) Particulars of the lightest type of passenger engine we have in service. Type 4-4-0 class. Cylinders 17 $^1/_2$ × 26 inches stroke. Steam ports 15 × 1 $^1/_4$ inches. Exhaust 15 × 2 $^3/_4$ inches. Boiler 10 ft. 3 in. long × 4 ft. 2 in. inside diameter. Fire-box shell (round top) 5 ft. 2 $^5/_8$ in. × 3 ft. 9 in. Inside copper fire-box 5 ft. 2 $^3/_8$ in. long by 3 ft. 9 in. wide × 5 ft. 4 $^3/_4$ in. deep at front end × 4 ft. 2 $^3/_4$ in. deep at back end. Heating surface of fire-box, 90·5 square feet; heating surface of tubes, 943·5 square feet; total, 1,034·0 square feet. Number of tubes 194 × 1 $^3/_4$ inches outside diameter. Grate area 19·25 square feet. Diameter of bogie wheels 3 ft. 7 $^3/_4$ in. Diameter of coupled wheels 6 feet. Diameter of tender wheels 3 ft. 7 $^3/_4$ in. Water capacity of tenders 2,000 gallons. Coal capacity of tender 4 tons.

	Empty.	Working order.
Total weight on bogie.	12 t. 0 c. 2 q.	12 t. 12 c. 2 q.
Pair driving wheels.	13 t. 19 c. 0 q.	15 t. 11 c. 0 q.
— trailing wheels.	12 t. 11 c. 3 q.	14 t. 1 c. 0 q.
— leading tender wheels	6 t. 1 c. 0 q.	9 t. 10 c. 0 q.
— intermediate tender wheels. . .	5 t. 13 c. 0 q.	8 t. 16 c. 0 q.
— trailing tender wheels.	5 t. 0 c. 0 q.	9 t. 3 c. 0 q.
	55 t. 5 c. 1 q.	69 t. 13 c. 2 q.

London & North Western Railway. — *a*) No. — *b*) We work our light passenger trains with tank locomotives.

London Brighton & South Coast Railway. — *a*) Class 1 : No the small locomotives adopted to haul and push trailer cars are found to meet all requirements.

Midland Railway. — *a*) A small type of existing engine has been adopted to suit requirements.

North Staffordshire Railway. — *a*) No.

North Eastern Railway. — *a*) We have made a combination of engine and carriage by utilising some of our lighter engines and attaching to them a carriage with an arrangement for driving the engine from the other end of the carriage. See appendix II. They are not however strictly speaking, automotor cars.

Port Talbot Railway. — No.

Rhymney Railway. — No.

South Eastern & Chatham Railway. — *a*) We are building two small locomotives for working light trains instead of automotor cars. These small engines have inside cylinders 12 inches diameter × 18 inches stroke 6-coupled wheels 3 ft. 9 in. diameter side tanks with coal bunkers at back end. Ordinary locomotive type of boiler 440 square feet heating surface; 9 square feet grate. Working pressure 180 lb. per square inch. Weight empty about 19 tons. Full weight at work about 24 tons. Load per pair of wheels about 8 tons.

Taff Vale Railway. — *a*) We have fitted up a small locomotive to run between two coaches forming a "motor train" capable of being driven from either end, from a specially equipped compartment, in which the motorman rides, and whence he has complete control of the train. The assistant motorman remains on the foot plate to attend to the engine there being electrical communication between the motorman and his assistant. We have two of these motor trains on service. One coach has seating accommodation for 86 passengers (16 first, 42 non-smoking

3rd and 28 3rd smoking class) and the other 80 passengers (56 non-smoking and 24 smoking all 3rds). Total per train 166 passengers. The trains are lighted by incandescent gas and heated by steam, G.-D. Peters' system.

Weight of engine in working order :

Bogie.	14 t. 4 c.
Driving wheels	15 t. 10 c.
Trailing wheels.	15 t. 14 c.
Total.	45 t. 8 c.

Dublin & South Eastern Railway. — *a*) Yes-have adopted light locomotives. See figs. 17 & 18.

Great Northern Railay (Ireland). — *a*) No. Special engines have been designed for this service but small bogie tank engines are used.

Central South African Railways.— It is not contemplated to specially design small locomotives for light trains. Should our present motor car service require extension, we have several such locomotives too light for other work, at present lying idle. A suitable coach would be designed for attachment to these engines.

South Australian Government Railways. — No.

Great Indian Peninsula Railway. — We have considered the adaptibility of small tank engines which have seen many years service and are now obsolete. One has been fitted up and is now in service.

Madras & Southern Mahratta Railway. — Yes. — It is contemplated to use some small tank locomotives.

II. — Organization of the service and modus of working.

QUESTION 1. — *a*) *Whether motor cars are worked alone or with trailers.* — *b*) *If trailers used, is there intercommunication between motor cars and trailer.* — *c*) *If continuous brakes used exclusively.*

Alexandra (Newport) Docks and Railway. — *a*) We used them with trailing cars. — *b*) No. — *c*) Continuous brakes not used.

Furness Railway. — *a*) Trailing cars. — *b*) Yes. — *c*) Yes.

Great Central Railway. — *a*) Trailing cars. — *b*) No. — *c*) Yes.

Great Western Railway. — *a*) They work alone or with trailers attached as required. — *b*) In cases where a small locomotive is employed with two trailer cars attached at each end, intercommunication is provided between the trailers.

Lancashire & Yorkshire Railway. — *a*) Eight cars are designed to work exclusively isolated, but six of these haul an extra-ordinary coach during heavy traffic. Seven other cars have been designed to work exclusively or to haul a specially designed trailer car. — *b*) Yes. — *c*) The automatic vacuum brake is continuous — the brake valves operate both cars.

London & North Western Railway. — *a*) Isolated — no trailing cars allowed. — *c*) Yes when running; a hand brake is provided for occasional use if required.

London Brighton & South Coast Railway. — *a*) Are used with standard coaches attached on special occasions. — *b*) No. — *c*) Class 1 : Yes. Class 2 : The brake being the automatic vacuum precludes this unless extra coach happens to be dual fitted.

Midland Railway. — *a*) Class 1 : One trailer is allowed. Classes 2 and 3 : Equal to two extra vehicles fully fitted may be conveyed in the rear of any of these trains when necessary. — *b*) In each class, the control is limited to that of part the arrangement distinct from the trailers, except so far as braking is concerned over which the guard has control, and his position is in the rear of the train. — *c*) See question 1-B 7 for braking. All vehicles used are vacuum fitted.

North Staffordshire Railway. — *a*) Not exclusively isolated always. Sometimes use one or more trailer cars but motor cars were only designed to haul one trailer car. — *b*) No. — *c*) Yes.

North Eastern Railway. — *a*) Isolated. — *c*) No.

Port Talbot Railway. — *a*) Trailer used when required. — *b*) No. — *c*) Yes.

Rhymney Railway. — *a*) With trailing cars. — *b*) No. — *c*) Yes except that one vehicle without continuous brake may be taken in rear.

South Eastern & Chatham Railway. — *a*) We employ cars isolated and with trailing cars. — *b*) There is no intercommunication between the automotor car and the trailing car. — *c*) Plant with continuous brakes used exclusively.

Taff Vale Railway. — *a*) Principally with trailing coaches. — *b*) Yes. — *c*) Yes.

Dublin & South Eastern Railway (Ireland). — *a*) Usually with trailers. — *b*) No. — *c*) Yes.

Great Northern Railway (Ireland). — *a*) With trailing cars. — *b*) No. — *c*) Yes.

Central South African Railways. — *a*) Both types of our cars are used isolated. No trailers are attached.

South Australian Government Railways. — *a*) The only trailing vehicle used with these cars is a small covered goods van weighing 3 tons 11 cwts, limited to a load of 6 tons. There is no means of communication between the van and car.

Great Indian Peninsula Railway. — *a*) Employed exclusively isolated. — *c*) Yes.

Madras & Southern Mahratta. — *a*) Both. — *b*) No. — *c*) Yes.

QUESTION 2. — *a*) *Number of "Traction Agents" employed.* — *b*) *Number of "Working Agents" employed.* — *c*) *Whether the number of men is the same when taking a trailer as when running alone.*

Alexandra (Newport) Docks and Railway. — *a*) The mechanical working of the car is in charge of a driver assisted by a fireman. — *b*) A conductor.

Furness Railway. — *a*) Two. — *b*) Two. — *c*) Yes.

Great Central Railway. — *b*) Two men employed on all cars and no more.

Great Western Railway. — *a*) Two (engineman and fireman). — *b*) One (conductor). — *c*) On branch and main line long distance services, one conductor as guard. On suburban services one conductor to each car owing to passage not being provided between the cars.

Lancashire & Yorkshire Railway. — *a*) The handling of each car is entrusted to three men, driver, fireman and conductor.

London & North Western Railway. — *a*) Two. — Driver and stoker. — *b*) One attendant is attached to each car.

London Brighton & South Coast Railway. — *a*) Classes 1 and 2 : Two. — Classes 3 and 4 : One. *b*) One. All classes. — *c*) Staff remains the same. All classes.

Midland Railway. — *a*) Driver and fireman. — *b*) Guard. — *c*) Same staff under all conditions.

North Staffordshire Railway. — *a*) Two motormen are always employed, one being an established locomotive driver and the other a "passed" driver, as he is practically in charge of the car when running backwards. — *b*) Guard.

North Eastern Railway. — *a*) One driver only. — *b*) One guard.

Port Talbot Railway. — *a*) One. — *b*) Nil.

Rhymney Railway. — *a*) Driver and stoker. — *b*) One conductor.

South Eastern & Chatham Railway. — *a*) Driver and stoker. — *b*) One guard. — *c*) Same staff in all cases.

Taff Vale Railway. — *a*) One motorman and assistant. — *b*) One conductor. — *c*) The number of conductors depend on the number of trailer cars.

Dublin & South Eastern Railway. — *a*) See question 5. — *b*) One. — *c*) Same staff.

Great Northern Railway (Ireland). — *a*) One only. Fireman remains at boiler.

Central South African Railways. — *a*) Driver and fireman. — *b*) Conductor-examiner.

South Australian Government Railways. — *a*) No. 1 car : Driver. — *b*) No. 1 car : Guard. *a*) No. 2 car : Driver and fireman. — *b*) No. 2 car : Guard.

Great Indian Peninsula Railway. — *a*) Driver and fireman. — *b*) Guard.

Madras & Southern Mahratta Railway. — *a*) Two. — *b*) Guard and fireman.

Question 5. — *a*) *If necessary to turn the motor car on a turntable at end of journey.* — *b*) *Whether any difference is made in speed when running "engine" end first or car end first.* — *c*) *If more than one car is attached, is it put on in front or behind.*

Alexandra (Newport) Docks and Railway. — *a*) No. — *b*) No. — *c*) We always attach the additional cars on behind.

Furness Railway. — *a*) No. — *b*) No. — *c*) No.

Great Central Railway. — *a*) Cars are drawn from either end.

Great Western Railway. — *a*) No. Driver always at leading end. — *b*) No difference in speed whichever way cars run. — *c*) Cars allowed to push one vehicle specially fitted with controlled gear at the outer end similar to that provided in driver's vestibule of motor car. No difference in speed.

Lancashire & Yorkshire Railway. — *a*) No. — *b*) No. The cars travel at 40 miles per hour in either direction. — *c*) Only one car is allowed to be attached. The specially constructed trailer car fitted with driving appliances is propelled, but the ordinary car is always drawn.

London & North Western Railway. — *a*), *b*) and *c*) No.

London Brighton & South Coast Railway. — *b*) No restrictions except by booked times, which allow of an average speed, deducting stops, of about 30 miles per hour in either direction. — *c*) The regular attached coach only is allowed to be pushed. The extra coach is attached to end of trailing coach or leading end of engine according to direction run.

Midland Railway. — *a*) and *b*) We have no cars with single cab and no turn-table is necessary as in each case the cars can be and actually are run in either direction as required. The maximum speed is 35 miles per hour. — *c*) Extra vehicles are always taken in the rear of the train.

North Staffordshire Railway. — *b*) No difference in speed when running in either direction. — *c*) No. Any cars attached to motor cars are always hauled, not pushed.

North Eastern Railway. — *b*) Full speed — no matter which end running in front. — *c*) No; single auto. only.

Port Talbot Railway. — *b*) 30 miles per hour either way.

Rhymney Railway. — *a*) Cars not turned as engine can be worked from either end of car. — *b*) 40 miles per hour. — *c*) No. Additional cars are always attached in the rear.

South Eastern & Chatham Railway. — *b*) 40 miles per hour from either end. — *c*) Cars are not pushed. The automotor shunts at end of journey. Additional cars always attached behind and drawn.

Taff Vale Railway. — *a*) No. The motorman travels on the engine in one direction and in a compartment of a carriage in the opposite direction and indicates to the Assistant by a code of signals the proper time to start and stop. — *b*) There is no limit to the speed in any direction under the maximum limit for both directions. — *c*) We do not practise this mode of working.

Dublin & South Eastern Railway (Ireland). — *a*) Engine is shunted around train. — *b*) and *c*) No.

Great Northern Railway (Ireland). — *a*) No cars like this. — *b*) Speed same in each direction. — *c*) Only one car attached to motor car and it is drawn on one journey and pushed on return journey.

Central South African Railways. — *b*) Maximum speed 40 miles per hour (Class 1). — Maximum speed 30 miles per hour (Class 2).

South Australian Government Railways. — *a*) Yes. — *b*) 26·3 miles average speed both ways.

Great Indian Peninsula Railway. — *a*) No. — *b*) Same speed as when running engine leading. — *c*) A second car could be worked if desired, attached behind.

Madras & Southern Mahratta Railway. — *b*) Maximum speed same in both cases. — *c*) No.

*

North Western State Railway of India. — *b*) 26 miles per hour booked speed irrespective of which end is leading. — *c*) No pushing allowed. Attached cars trailing.

QUESTION 4. — *Does the driver when travelling car end first, ride in the auxiliary cab and the stoker remain in the engine cab or vice-versa ?*

Alexandra Newport Docks & Railway. — The driver takes his post in the auxiliary cab when the car travels backwards, and the stoker remains in the engine cab.

Furness Railway. — Stoker always remains in engine cab.

Great Central Railway. — Driver in front. Fireman always on engine.

Great Western Railway. — Yes. Driver always at leading end and fireman always in engine cab. (Driver and fireman together when travelling in one direction and separated when travelling in the other.)

Lancashire & Yorkshire Railway. — Yes. The driver goes to the auxiliary cab. Stoker remains on engine.

London & North Western Railway. — The driver, when the car is travelling backward, takes his place in the auxiliary compartment, and the fireman or stoker remains in the engine compartment.

London, Brighton & South Coast Railway. — Driver and stoker on engine when pulling. Driver in car cab compartment and stoker on engine when pushing.

Midland Railway. — The driver is in all cases at the front of the car, that is, in the auxiliary cab when this is in front, and then the stoker is not with the driver.

North Staffordshire Railway. — Driver always remains in engine cab, and assistant driver goes to auxiliary cab when running backwards.

North Eastern Railway. — Only one motorman employed and he always in the leading cab. Driver always in the leading cab. Guard in the rear cab.

Port Talbot Railway. — Yes.

Rhymney Railway. — The driver works in the auxiliary cab and the stoker in the engine cab.

South Eastern & Chatham Railway. — The driver in the case of travelling backwards takes his post at the drivers compartment at the end of car. Stoker remains on engine.

Taff Vale Railway. — Yes.

Great Northern Railway (Ireland). — Driver is always in front cab.

Central South African Railways. — When travelling backwards in both cars, the driver operates the car from the drivers compartment or auxiliary cab at end of coach, the fireman remains on the locomotive footplate.

South Australian Government Railways. — The driver takes his place in the auxiliary cab and the fireman on the engine.

Great Indian Peninsula Railway. — Yes.

Madras & Southern Mahratta Railway. — Yes.

North Western State Railway of India. — Driver always in leading end.

QUESTION 3. — *a) In the case of small locomotives (questions 1 to 13) is the handling entrusted to one man only. — b) Are the motor cars and their trailers fitted with continuous brakes. — c) Is there intercommunication with the car and trailer. — d) If any arrangement adopted for continuous automatic feeding of fire-box.*

Alexandra (Newport) Docks and Railway. — *a*), *b*), *c*) and *d*) No.

Furness Railway. — *a*), *b*) *c*) and *d*) No.

Great Central Railway. — *b*) Yes through all vehicles. — *d*) No.

Great Western Railway. — *a*) No. — *b*) Yes. — *c*) Usually one trailer hauled or propelled by motor car. Electrical communication. — *d*) No.

Lancashire & Yorkshire Railway. — *a*) No. — *b*) Continuous brakes are used on rail coach and all other coaches that are hauled. — *c*) Intercommunication can be made with the rail motor coach and the specially designed trailer coach. — *d*) No.

London & North Western Railway. — *b*) Our cars are fitted with the continuous brake. — *d*) No.

London, Brighton & South Coast Railway. — No.

Midland Railway. — *b*) Yes; we have vacuum brake communication with all trailers. — *d*) No liquid fuel or automatic feeding used.

North Eastern Railway. — See appendix II.

Port Talbot Railway. — *a*) Yes. — *b*) No. — *d*) No.

South Eastern & Chatham Railway. — *a*) Driver and stoker are employed. — *b*) We use continuous brakes upon motor cars and also where they haul trailer cars. — *c*) There is no intercommunication with the car hauled. All cars are hauled not pushed. — *d*) No.

Taff Vale Railway. — *a*) The starting, stopping, operating the reversing lever and attending to the boiler is in the hands of the assistant motorman, but the look-out for road-signals and the signal for starting and stopping is in the hands of the motorman. — *b*) All cars fitted with continuous brakes. — *c*) No intercommunication with the first car hauled. — *d*) No.

Dublin & South Eastern Railway. — *a*) No. — *b*) Continuous brakes on engine and all cars. — *c*) No intercommunication with cars. — *d*) No.

Great Northern Railway (Ireland). — *a*) No. — *b*) Yes. — *c*) No intercommunication. — *d*) No.

Central South African Railways. — See answer to No. 2.

South Australian Government Railways. — *a*) No.

Great Indian Peninsula Railway. — *a*) No. — *b*) Automatic Vacuum Brake on all. — *c*) No.

Madras & Southern Mahratta Railway. — *b*) Yes. — *c*) No. — *d*) No.

North Western State Railway of India. — *d*) Coal.

QUESTION **6.** — *Profile of line over which cars work giving distances between stations, gradients and radius of curves.*

Alexandra (Newport) Docks & Railway. — See fig. 41.

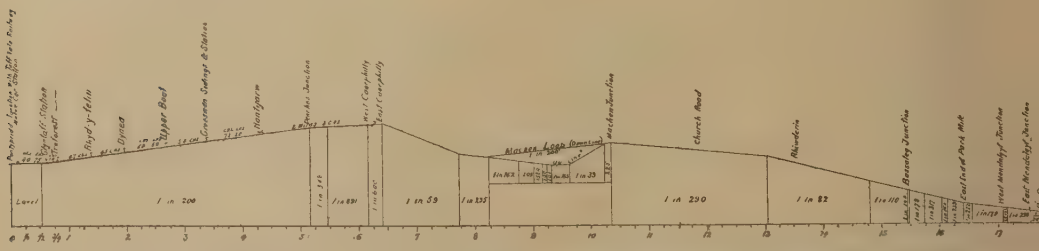
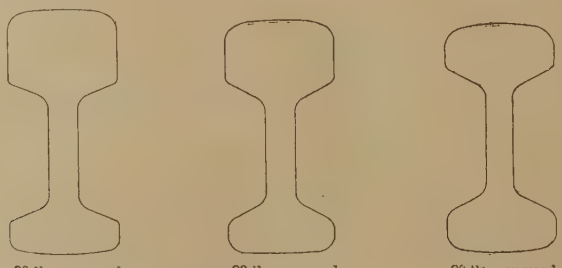


Fig. 41. — Alexandra (Newport) Docks & Railway Company. — Section of railway from Pontypridd Junction to Alexandra



90 lb. per yard. 83 lb. per yard. 80 lb. per yard.

Fig. 42. — Alexandra (Newport) Docks & Railway Company. — Pontypridd to Penrhos Junction. Section of rails

Great Central Railway. — Maximum gradient 1 in 50. Brymbo Branch.

Great Western Railway. — Stonehouse to Chalford. Merthyr to Newport. Maximum gradient 1 in 34.

London & North Western Railway. — See figs. 43 to 48.

Midland Railway. — See figs. 49 to 60.

North Staffordshire Railway. — See figs. 61 and 62.

North Eastern Railway. — Section of Selby & Wistow line herewith. Section of Scarborough and Filey line on which the cars were engaged prior to 1908.

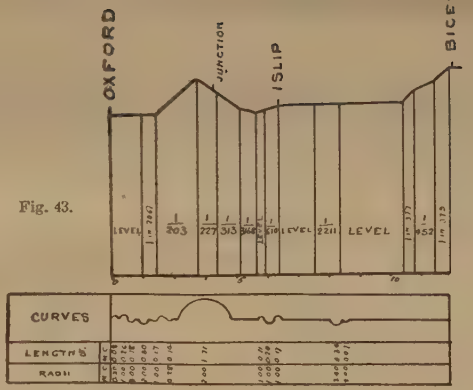


Fig. 43.

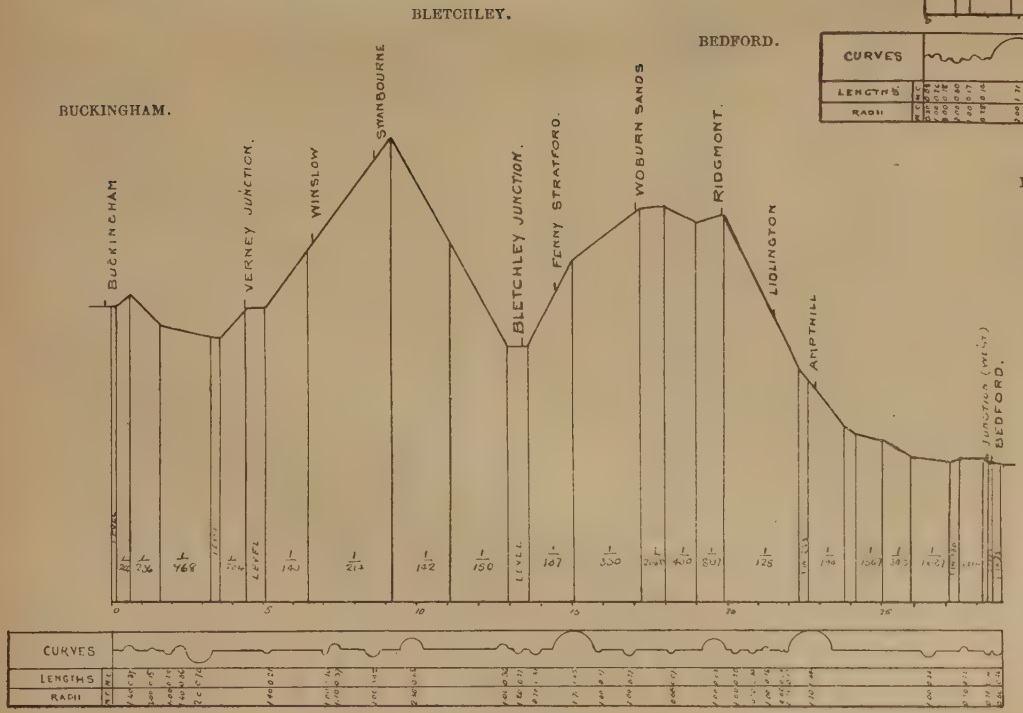


Fig. 44.

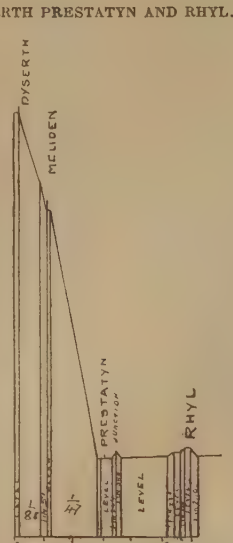


Fig. 45.

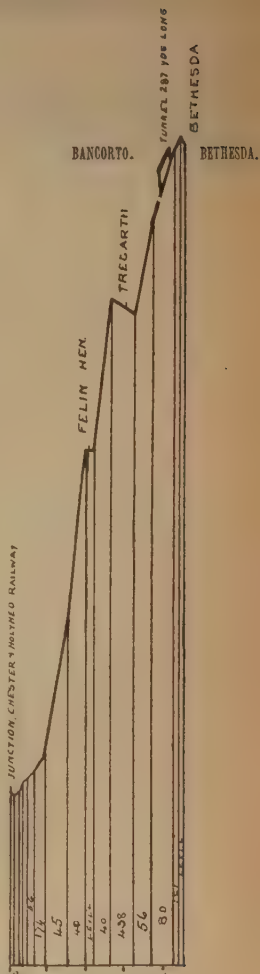


Fig. 46.

Figs. 43 to 46. — London & North Western Railway. — Gradient diagram of branch lines worked by steam motor carriages.

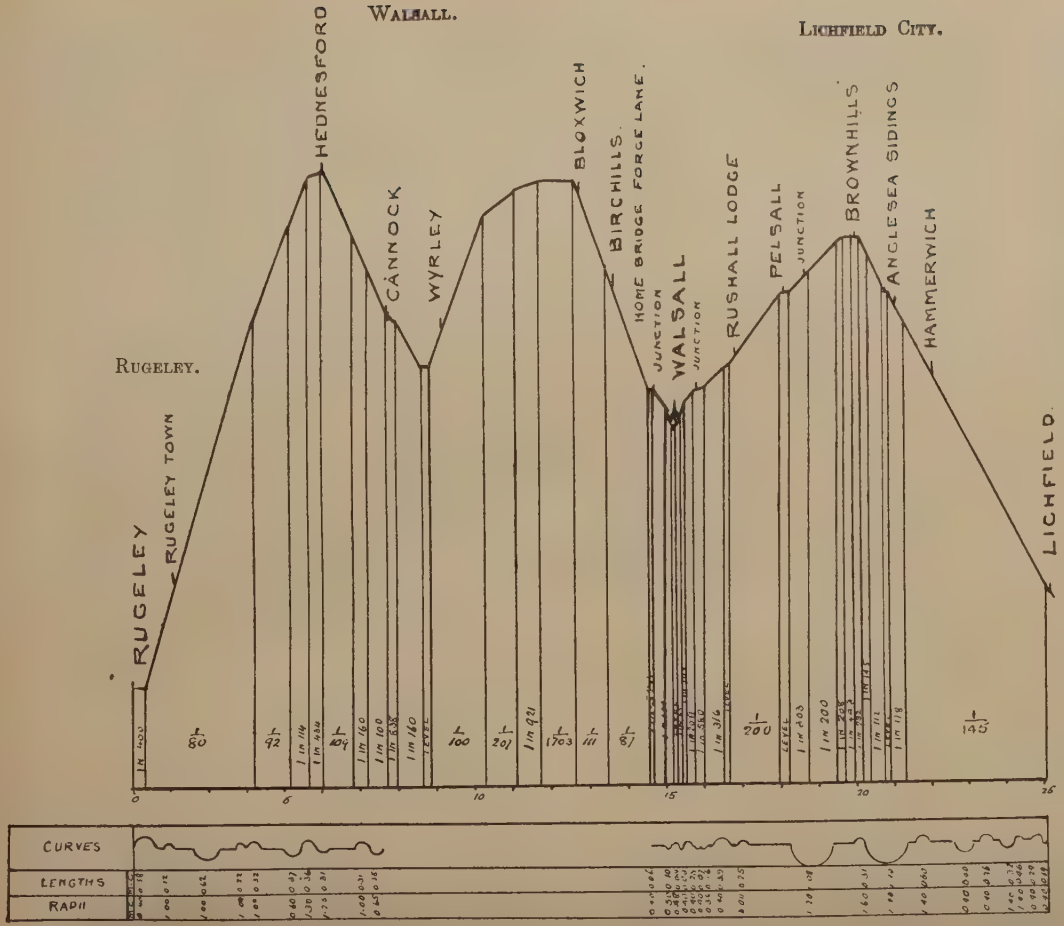


Fig. 47.

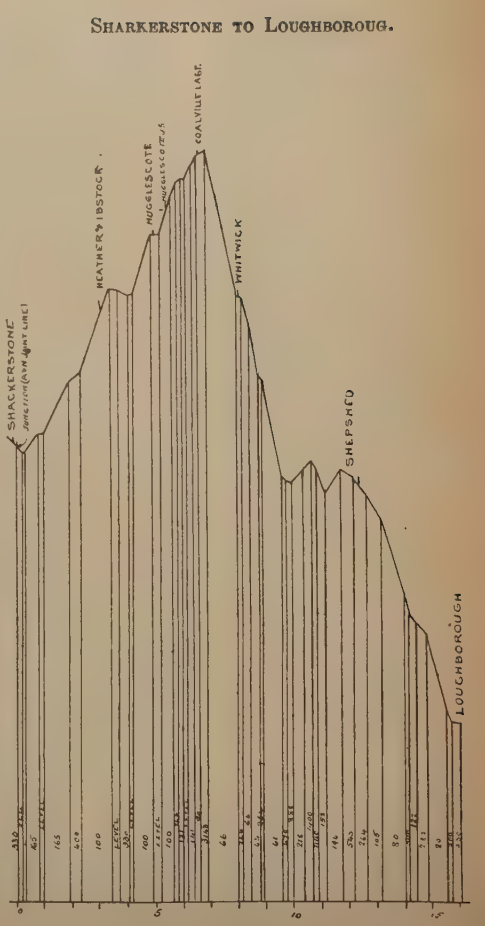


Fig. 48.

Figs. 47 and 48. — London & North Western Railway. (*Continued.*) — Gradient diagram of branch lines worked by steam motor carriages.

Fig. 49.

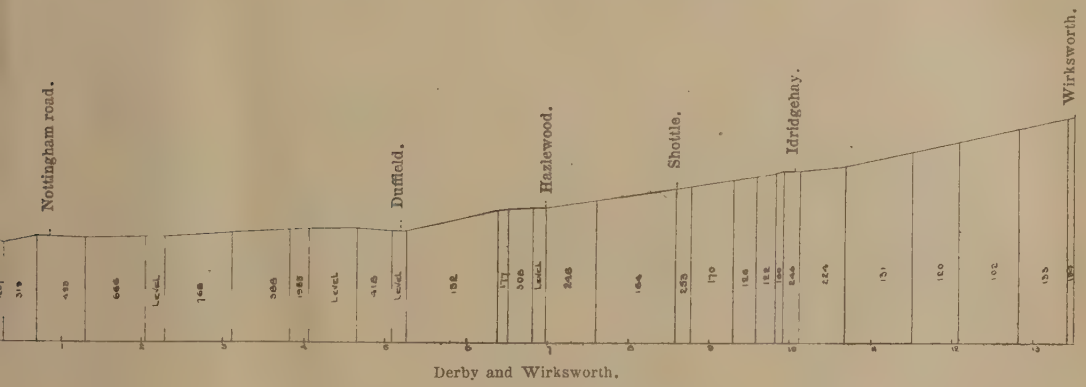


Fig. 50. — Midland Railway. — Gradients.

Dublin & South Eastern Railway. — See figure 65.

Central South African Railways. — Class 1 : is worked on a section of the line whose ruling gradient is 1 in 50. — Class 2 : is worked on a section of the line whose ruling gradient is 1 in 100 except for a short piece which is 1 in 70.

Great Indian Peninsula Railway. — Cars run from Victoria Terminus to Kurla.

Madras & Southern Mahratta Railway. — See figures 67 to 73.

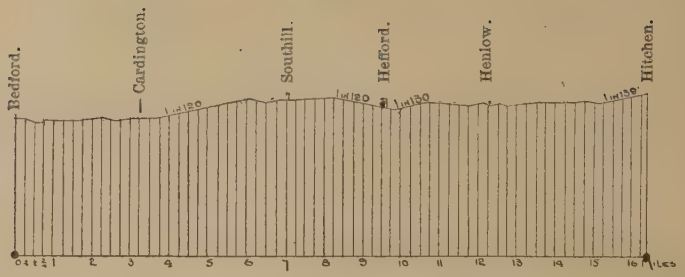


Fig. 51. — Bedford to Hitchen 16 miles 29 chains.

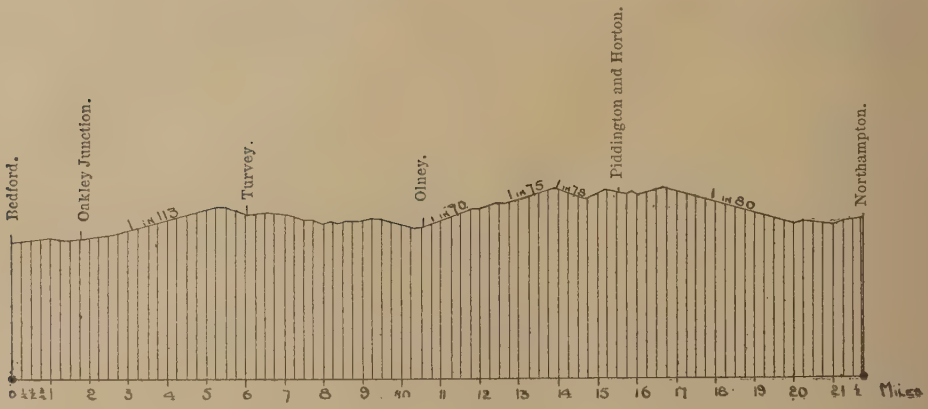
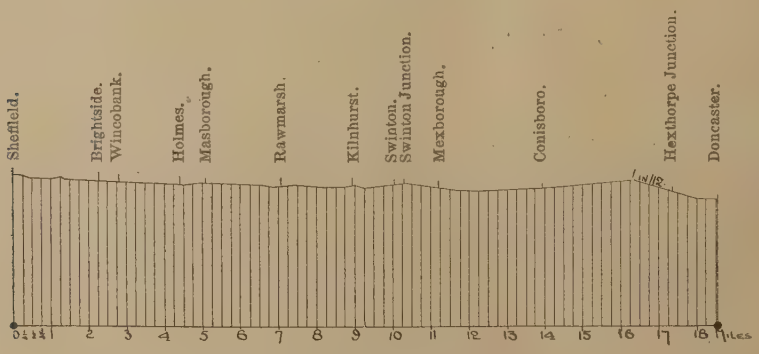


Fig. 52. — Bedford to Northampton 21 miles 64 chains.



Sheffield to Doncaster 18 miles 44 chains.

Fig. 53. — Diagram of gradients on Midland Railway steam motor train routes.

Fig. 54. — Midland Railway. — Gradients.

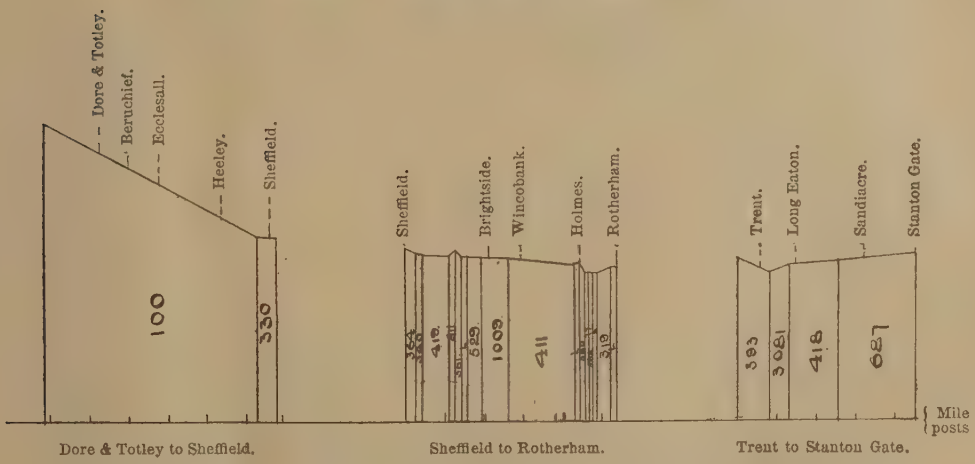


Fig. 55. — Midland Railway. — Gradients.

QUESTION 7. — *Daily services performed by cars : a) Stations at each end and mileage. — b) If services divided into two stages worked by different cars.*

Alexandra (Newport) Docks & Railway. — *a*) Fourteen journeys to and from Pontypridd. Pontypridd and Caerphilly. Mileage corresponding to each run 6 ½ miles. The cars run alternate days. Total running per day 182 miles. — *b*) No.

Furness Railway. — *a*) Coniston to Foxfield 10 miles. Three intermediate stops. Eight trips (single) Foxfield to Broughton and back 2 miles. Total mileage per car per day 82 miles.

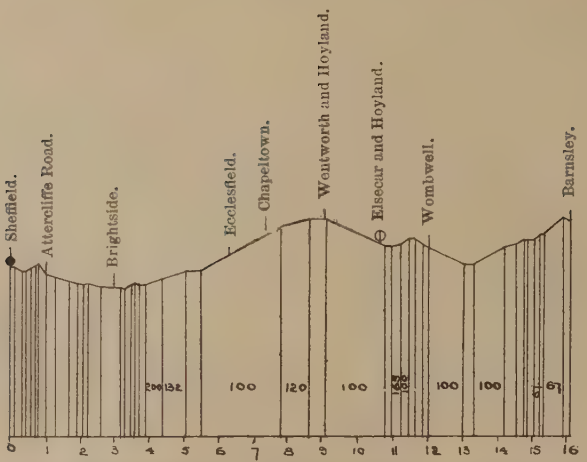


Fig. 56. — Midland Railway. — Sheffield to Barnsley. — 16 miles 11 chains.

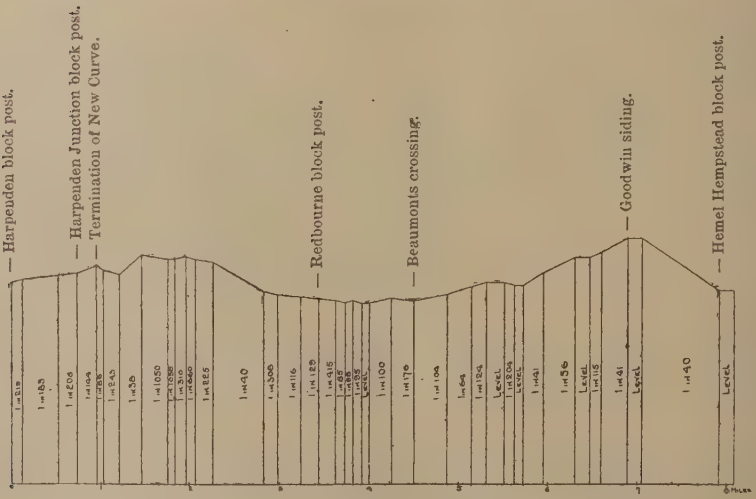


Fig. 57. — Midland Railway. — Gradients from Harpenden to Hemel Hempstead.

Great Central Railway. — *a*) See time-tables. — *b*) No.

Great Western Railway. — *a*) See details. Time-tables. — *b*) One stage only. Practically only one type of car as far as design of engine is concerned. Maximum daily working of one car at present is 220 miles.

Lancashire & Yorkshire Railway. — *a*) Separate statement. — *b*) No.

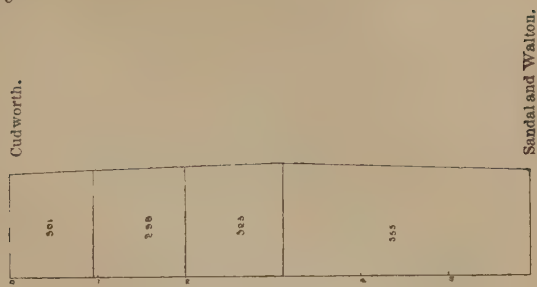


Fig. 58. — Cudworth and Sandal Walton.

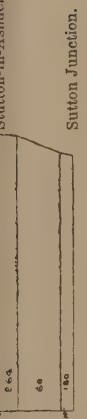


Fig. 59.

ton-in-Ashfield
Sutton Junction.

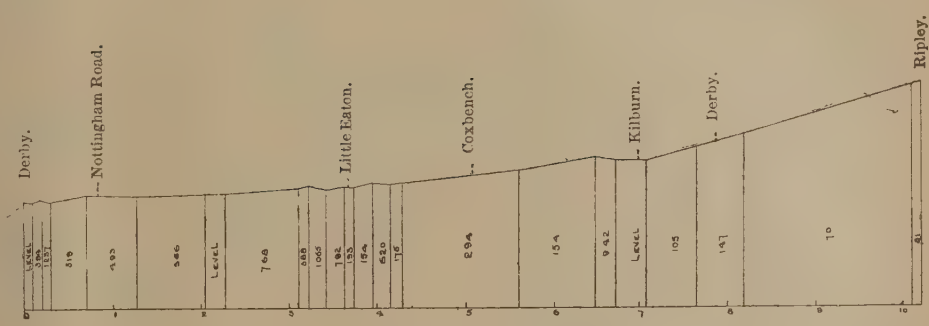


Fig. 60. — Derby and Ripley.

Figs. 58 to 60. — Midland Railway. — Gradients.

London & North Western Railway. — *a*) See time-tables. — *b*) No.

London, Brighton & South Coast Railway. — No services are divided. The maximum daily working on any service is 292 miles.

Midland Railway. — *a*) See time-table.

North Staffordshire Railway. — *a*) General total of 1,000 miles per week for three cars. Maximum number of miles worked in one day 89 miles. — *b*) No.

North Eastern Railway. — *a*) Selby and Wistow and return four times daily. Distance, 5 1/4 miles. Total, 42 miles. Petrol Electric Autocars. Selby and York return. One journey daily. Distance, 28 miles. Petrol Electric Automotor car. Total mileage per day, 70.

Port Talbot Railway. — *a*) 105 miles per day.

Rhymney Railway. — *a*) One car makes eight journeys of 4 1/2 miles each. Senghenydd and Caerphilly, and four journeys of 8 1/2 miles each Senghenydd and Machen. Total, 70 miles. The other car makes eight journeys of 10 miles each Rhymney and Ystrad Mynach, and two journeys of 11 miles each, Merthyr and Ystrad Mynach. Total, 102 miles. Total of both cars per day 172 miles. — *b*) No.

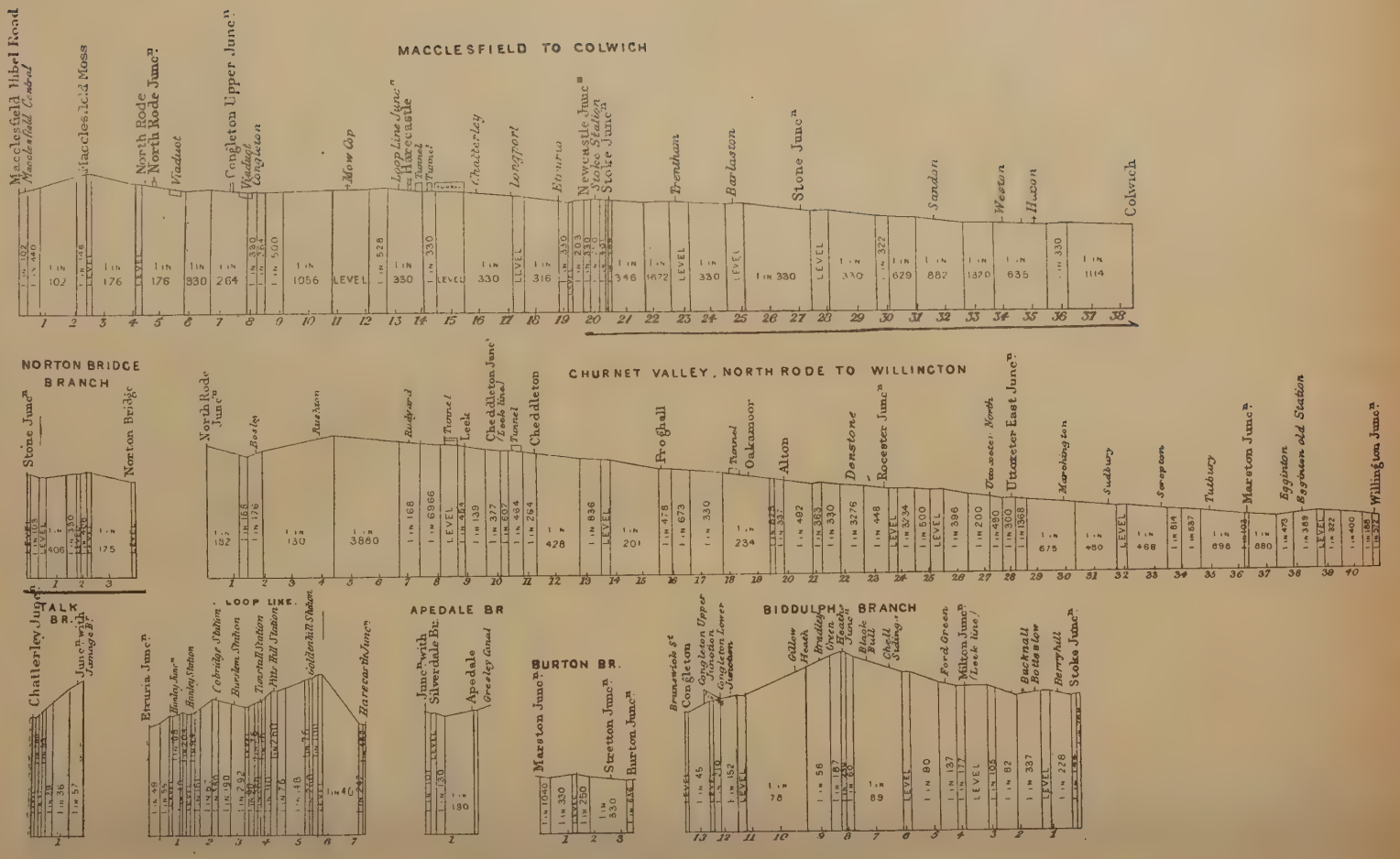


Fig. 61. — North Staffordshire Railway. — Diagram of gradients. [Lines on which run are underlined by a large line.

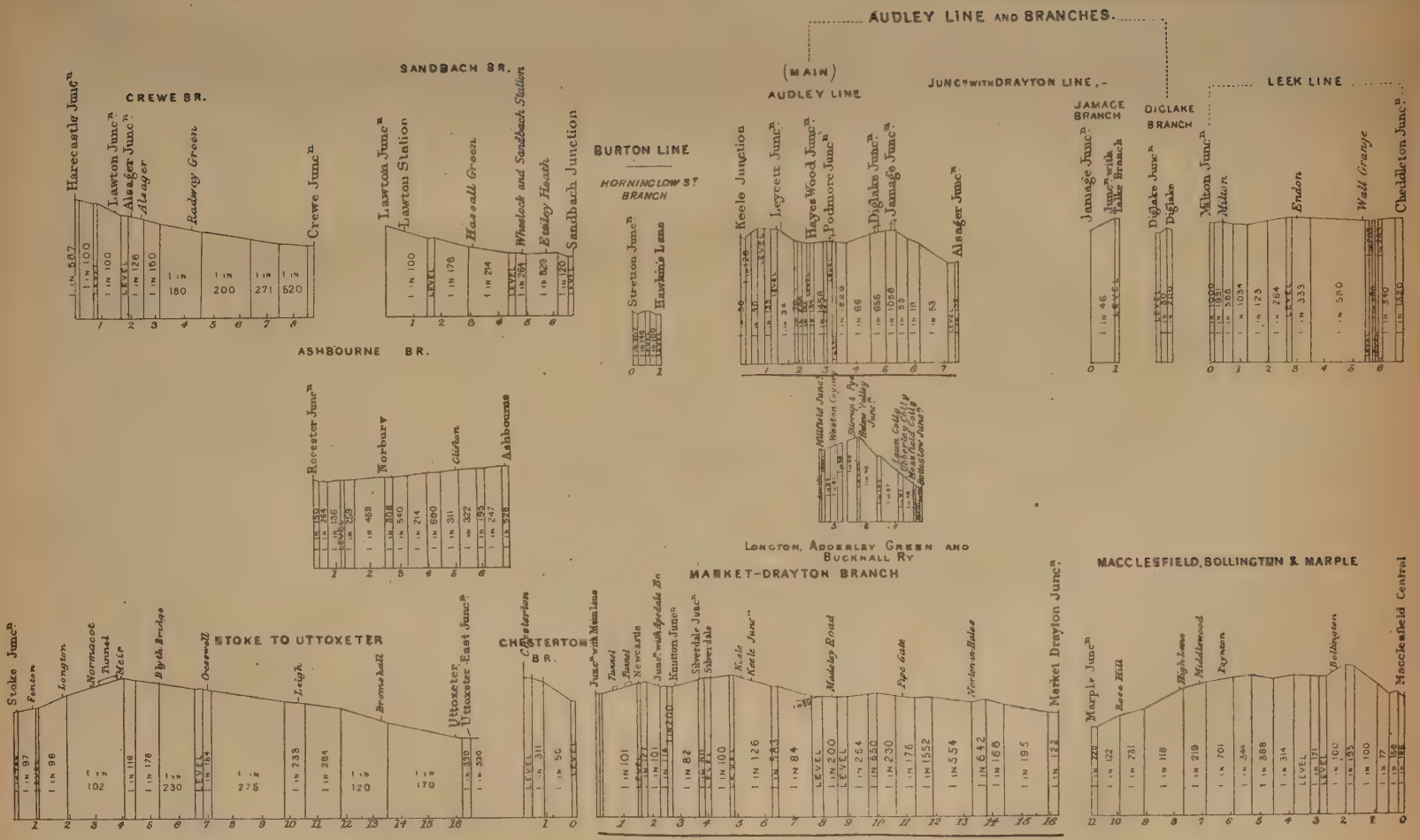


Fig. 62. — North Staffordshire Railway. (*Continued.*) — Diagram of gradients. Lines on which run are underlined by a large line.

Fig. 63. — North Eastern Railway. — Gradients between Filey & Scarborough.

Fig. 64. — North Eastern Railway. — Gradients between Cawood, Wistow and Selby.

Weight 85 lb. to the yard section of rail.

Fig. 66.

Rails 30 feet long
10 sleepers to the rail.

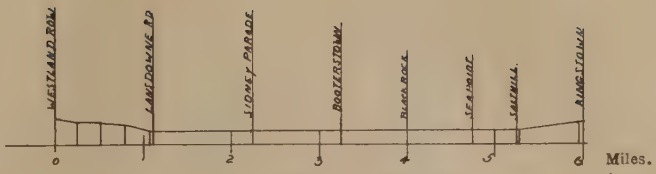


Fig. 65. — Dublin to Kingstown gradient chart.

Figs. 65 and 66. — Dublin and South Eastern Railway.

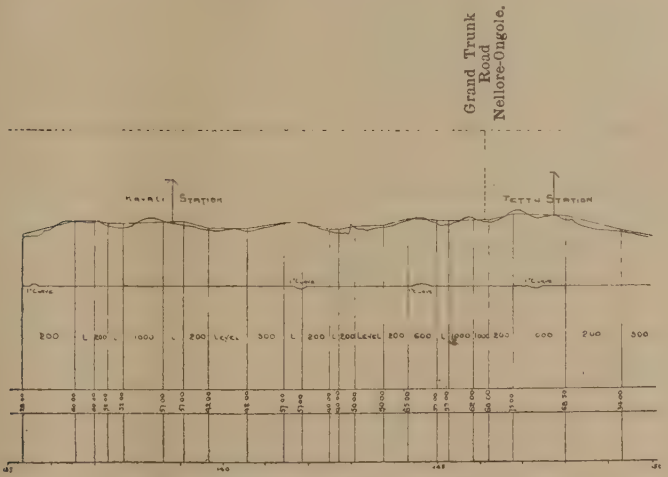


Fig. 67. — Madras and Southern Mahratta Railway.

Grand Trunk Road Nellore-Ongole.
8 spans 40 feet girders.
8 spans 40 feet girders.
4 spans 40 feet girders.
Allupa Road Station
Bitragunta Station

Fig. 68. — Madras and Southern Mahratta Railway.

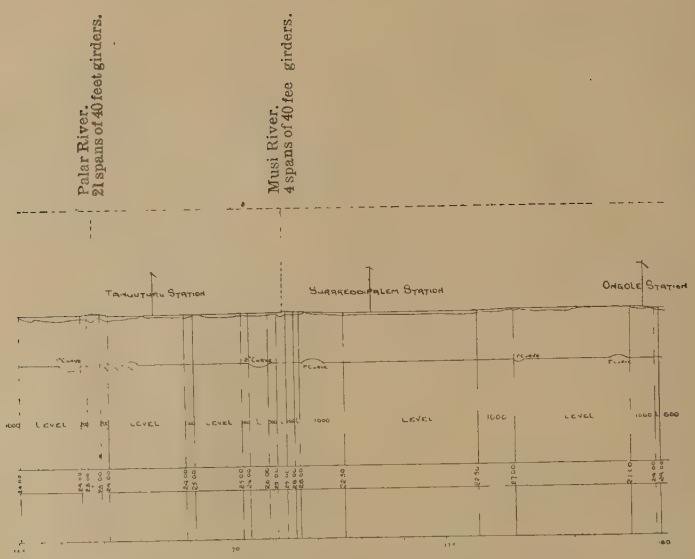


Fig. 69. — Madras & Southern Mahratta Railway.

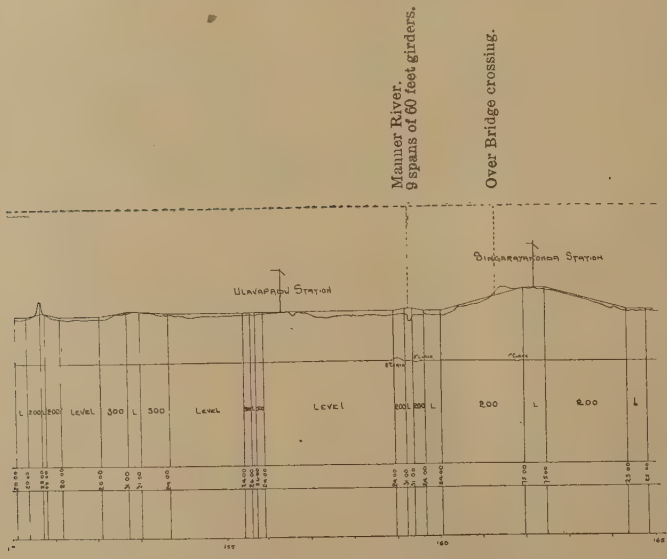


Fig. 70. — Madras & Southern Mahratta Railway.

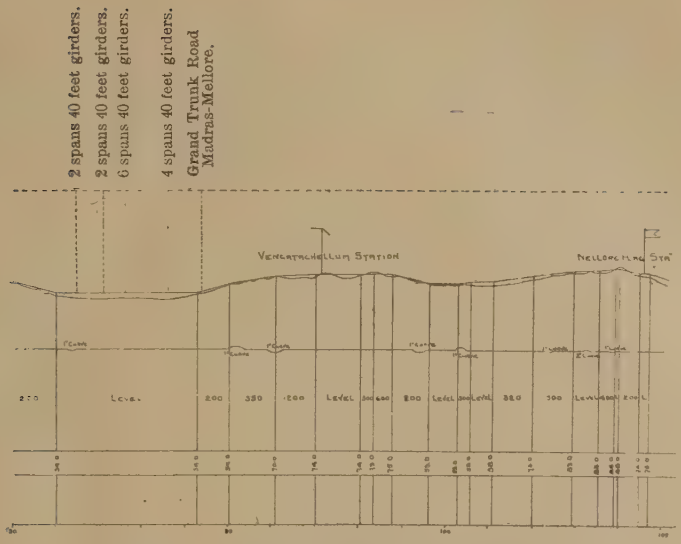


Fig. 71. — Madras & Southern Mahratta Railway.

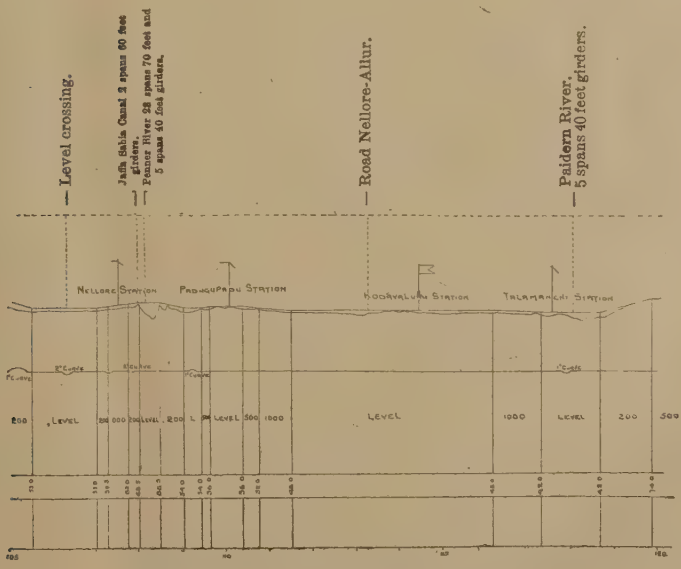


Fig. 72. — Madras & Southern Mahratta Railway.

Fig. 73. — Madras & Southern Mahratta Railway.

Taff Vale Railway. — *a*) For particulars of services see time-tables. The runs between terminal points vary from 4 miles 29 chains to 21 miles 32 chains. The aggregate miles per day between terminal points range from 42 $^{3}/_{4}$ miles to 148 $^{3}/_{4}$ miles. Total miles per day run by all cars, 1,059.

Central South African Railway. — *a*) Class 1 : runs on the Pretoria Suburban Service, the longest runs being to Hatherley, 12 miles, to the East, and Pretoria North, 9 miles to the North. The total daily mileage is about 125 miles. — Class 2 : runs on the Germiston Suburban Service to Elsburg, 5 miles to the south, and Rietfontein 5 miles to the west of that place. The total daily mileage is about 125 miles.

South Australian Government Railways. — *a*) These cars do not run a daily service. Average run about 100 miles per trip.

Great Indian Peninsula Railway. — *a*) Average 40 miles per day.

Madras & Southern Mahratta Railway. — *b*) No.

Question 8. — *a) Average weight empty.* — *b) Average weight when at work.* — *c) Number of axles of the cars.*

Alexandra (Newport) Docks and Railway. — *a*) No. 1 : 36 tons; No. 2 : 39 tons. — *b*) No. 1 : 40 tons; No. 2 : 43 tons. — *c*) Number of axles, 4.

Furness Railway. — *a*) Total weight full car and trailer, 56 tons 7 cwt. — *c*) Number of axles, 6.

Lancashire & Yorkshire Railway. — *a*) Weight of trailer coach empty, 26 tons 4 cwt. — *b*) With full complement of passengers and one ton of luggage, 31 tons 5 cwt. — *c*) Four axles.

London Brighton & South Coast Railway.

Class 1 :				
Engine.	Empty.	22	0	—
	Loaded	27	2	—
Coach	Empty.	23	15	—
	Loaded	28	0	—
Total	Empty.	45	15	—
	Loaded	55	2	—
Class 2 :				
Engine and car.	Empty.	30	3	—
	Loaded	38	7	—
Class 3 :				
Engine and car.	Empty.	14	0	—
	Loaded	17	10	—
Class 4 :				
Engine and car.	Empty.	17	4	—
	Loaded	20	14	—

North Staffordshire Railway. — *b*) Weight in working order, 32 tons 9 cwt. — *c*) Two axles on trailer car.

North Eastern Railway. — *a*) 35 tons. — *b*) 38 tons. — *c*) Only one self contained car is run.

Port Talbot Railway. — *c*) Four axles.

Rhymney Railway. — *a*) 55 tons 2 cwt. — *b*) 59 tons 4 cwt. 2 qrs. — *c*) Nine axles usually hauled by motor car.

South Eastern & Chatham Railway. — *a*) Trailing carriages average 12 tons empty. — *c*) Three axles.

Taff Vale Railway. — *a*) Large Car, 40 tons 5 cwt. — *a*) Small Car, 31 tons 19 cwt. — *b*) Large Car, 44 tons 11 cwt. — *b*) Small Car, 35 tons 14 cwt.

Great Northern Railway (Ireland). — *a*) About 22 tons. — *c*) Four axles.

Central South African Railway. — *a*) Class No. 1 : 40 tons; Class No. 2 : 39 $^1/_4$ tons. — *b*) Class No. 1 : 44 $^3/_4$ tons; Class No. 2 : 47 $^1/_2$ tons.

Great Indian Peninsula Railway. — *a*) Engine end 24 tons. — *b*) Engine end 27 tons.

Madras & Southern Mahratta Railway. — *a*) 11 tons 10 cwt. — *b*) 14 tons 10 cwt. — *c*) Two axles.

North Western State Railway of India. — *b*) 43 tons (without passengers). — *c*) 4 axles.

QUESTION 9. — *Average and maximum number of hauling cars and total weight inclusive of passengers luggage, etc.*

Furness Railway. — Maximum number of cars hauled, 3. Total weight including auto. motor, 72 tons 7 cwt.

Great Western Railway. — Car including passengers and luggage 49 tons approximately.

Lancashire & Yorkshire Railway. — One. Total weight in working order but without passengers is 49 tons 10 cwt. 2 qrs.

Midland Railway. — Class 1 : 1 haulage car. Weight without trailer (including passengers), 45 tons 16 cwt.; Weight with trailer (including passengers), 67 tons 14 cwt. — Class 2 : No trailers; 64 tons. Trailers might be any two vehicles of ordinary rolling stock. — Class 3 : No trailers; 85 tons 8 cwt. Trailers might be any two vehicles of ordinary rolling stock.

North Staffordshire Railway. — Only one trailing car is generally used, but an additional vehicle has been hauled on level road. Weight of one trailing car (loaded) 12 tons.

North Eastern Railway. — Each journey 1 car, weight 38 tons.

Rhymney Railway. — The average and maximum number of hauling cars are three, 6 wheels. Coaches weight when empty 37 tons 10 cwt., weight when at work 48 tons 15 cwt. No luggage.

Dublin & South Eastern Railway. — Maximum, 3. Average, 2. Maximum, 83 tons. Average, 67 tons.

Central South African Railways. — See No. 1 of this section.

Madras & Southern Mahratta Railway. — One trailer for passenger only.

North Western State Railway of India. — One bogie hauled. 24 tons light.

QUESTION 10. — *a) Number of cars owned. — b) Date of building first and last.— c) Number of units effectively employed in the daily service. — d) Average number of units stopped for washings, etc. — e) Annual mileage per motor car.*

Alexandra (Newport) Docks and Railway. — *a)* 2. — *b)* First in 1904, second in 1905. — *c)* 8. — *d)* One per week. — *e)* Mileage run in 1907 : No. 1 car, 20,321 miles; No. 2 car, 35.396 miles.

Furness Railway. — *a)* Only one in service. — *b)* 1905. — *d)* Replaced by locomotive when stopped for washing out, repairs, etc.

Great Central Railway. — *a)* 3 self contained, 2 separate.

Great Western Railway. — *a)* 100. — *c)* 79 daily employed.

Lancashire & Yorkshire Railway. — *a)* 2 cars with boilers of the double barrel type. — 6 cars with boilers of the locomotive type. — 7 cars with boilers of the locomotive type and

designed to couple up to specially designed trailer cars. — *b*) First car March 1905. Last car March 1907. — *c*) Annual mileage 33,551 miles.

London & North Western Railway. — *a*) 6 cars and 7 engines. — *b*) First car August 1905, last car April 1906.

London Brighton & South Coast Railway. — *a*) Class 1, 20; class 2, 2; class 3, 1; class 4, 1. — *b*) Class 1 : first car June 1905; last car April 1909; class 2 : Both built August 1905; class 3 : July 1905; class 4 : July 1905 converted to petro-electric, September 1908.

Midland Railway. — *a*) Class 1, 2; class 2, 4; class 3, 7. — *b*) Class 1 : July 1904; class 2 : February 1906; class 3 : July 1908. — *c*) Class 2 : Number actually running from time they commenced running, 2; class 3 : Number actually running from time they commenced running, 5; *e*) Class 1 : Average mileage per car for first four years 8,240 miles; class 2 : Average annual mileage 11,516 miles; class 3 : No figures for year. Average per week in July 1908, 475 miles per car.

North Staffordshire Railway. — *a*) Three. — *b*) Two in May 1905. 1 May 1906

North Eastern Railway. — *a*) Two. — *b*) 1904. — *c*) One. — *d*) One. — *e*) 10,920 miles.

Port Talbot Railway. — *a*) One only.

Rhymney Railway. — *a*) Two. — *b*) 1907. — *c*) Cars are in use daily. — *d*) Washing and cleaning is done at night time, and when in for repairs, trains hauled by locomotives work the service. — *e*) Annual mileage per car 13,326.

South Eastern & Chatham Railway. — *a*) Eight. — *b*) First in 1905 and last in 1906.

Taff Vale Railway. — *a*) Sixteen motor cars and two spare engines. — *b*) December 1903. June 1906. — *c*) Average mileage 19,922.

Dublin & South Eastern Railway. — *a*) Two. — *b*) 1906. — *d*) Stopped for washing out etc. on Sundays. — *e*) 16,956 miles.

Central South African Railways. — *a*) Two. — *b*) April 1906 and May 1907.

South Australian Government Railways. — *a*) Two. — *b*) 1906.

Madras & Southern Mahratta Railway. — *a*) Three. — *b*) 1907. — *c*) All cars have hitherto been at work.

North Western State Railway of India. — *a*) Only one car on system.

QUESTION 11. — *" For the small locomotives referred in questions 1 to 15 if you have such you ave asked to reply to questions 6 to 10 as above in as much as this may be of interest in regard to comparison with the automotor cars ".*

No information received in reply to this question beyond what is given in answer to other questions.

QUESTION 12. — *a*) *Whether motor car services are worked to time-table.* — *b*) *If considered as trains.* — *c*) *In the event of an extraordinary rush of passengers, do you put on supplementary trains worked by another automotor car or by a locomotive, or merely start a locomotive with a larger number of cars.* — *d*) *Are motor cars run to fixed times in connection with other trains or have they an exclusive character of local service.*

Alexandra (Newport) Docks and Railway. — *a*) Yes. — *b*) Yes, but when possible, additional accommodation is provided. — *c*) Yes. — *d*) The have an exclusive character of local service.

Furness Railway. — *a*) No. — *b*) No. — *c*) Extra vehicles are put on to car. — *d*) Run in connection with other trains.

Great Central Railway. — *a*) To time table only. — *b*) and *c*) Yes, strengthened when necessary if running engine first. — *d*) Same as other trains.

Great Western Railway. — *a*) Yes. — *b*) Yes, but seats not limited. When it is known there will be abnormal traffic beyond the capacity of a car and trailer, a locomotive and train or an auto-engine and trailers work the service. — *c*) In the case of a rush at short notice, the following alternatives are followed, as circumstances permit : 1° supplementary train run either by locomotive and train or automotor car; 2° locomotive and train substituted for automotor car; 3° additional trips by automotor car. — *d*) Cars submitted to fixed times with other trains.

Lancashire & Yorkshire Railway. — *a*) Yes. — *b*) No. They are considered as trains with only third class accommodation; in cases of extra traffic, a trailer coach is attached to the rail coach. — *c*) But when it is known that at a given time the traffic will exceed the capacity of the rail motor, it is replaced by an ordinary train. — *d*) The rail motor services are worked to fixed times with other trains.

London & North Western Railway. — *a*) Yes. — *b*) Yes. — *c*) We have occasionally found it necessary to run supplementary trains where the 6 cars are working. — *d*) They are exclusively local service, but have connection with main line trains.

London, Brighton & South Coast Railway. — *a*) Yes. — *c*) Such emergencies are foreseen and special ordinary trains are put on. Where the one car is likely to be overcrowded, the second is attached from ordinary stock but not more than one extra. — *d*) The motor car runs are scheduled with other trains and run with perfect punctuality to coincide with ordinary traffic.

Midland Railway. — *a*) Time shewn in time-tables and distinguished there as motor trains. — *b*) They are not trains with a limited number of seats. — *c*) Various devices have been tried when the traffic has been abnormally great, such as coupling two automotors of Class 1 together with two trailers and alternating the services of this train with a train hauled by an ordinary locomotive. Now, however, Class 1 is little used and then at places where no abnormal rush is to be expected. With Classes 2 and 3, two more coaches can be added to take the increased traffic. — *d*) These automotor trains do not run exclusively on any line but alternate with ordinary passenger trains and goods traffic, the times being fixed for each type in working and passenger timetables.

North Staffordshire Railway. — *a*) Yes advertised in time-tables as rail motors. — *b*) Yes. — *d*) In some cases the rail motors take the place of trains and otherwise run between ordinary trains.

North Eastern Railway. — *a*) Yes. — *b*) Yes. — *c*) Second auto car run if found necessary. — *d*) Local service purely except the run to York, which is run to fixed times and with other trains.

Port Talbot Railway. — *b*) No. — *d*) Fixed times.

Rhymney Railway. — *a*) Yes. — *b*) No. — *c*) Yes, if the automotor car is unable to take sufficient cars to accommodate the passengers, a locomotive with a larger number of cars to form the service. — *d*) Fixed times.

Taff Vale Railway. — *a*) Yes. — *b*) No. — *c*) Sometimes the cars are duplicated, at other time a relief train is provided. — *d*) Yes.

Dublin & South Eastern Railway. — *a*) Yes. — *b*) Yes. — *c*) Ordinary train put on in lieu of motor train. — *d*) Ordinary local service.

Central South African Railways. — *a*) The services of these cars are scheduled in the public timetable as in the case of the ordinary local suburban trains. The seating accommodation is limited, but on occasions, passengers are willing to stand, the average journey being very short.

South Australian Government Railways. — *a*) and *b*) Yes these cars are shewn in the time-tables and are considered as trains in every respect. — *c*) In the event of a rush of passengers. A train would have to be provided.

Great Indian Peninsula Railways. — *a*) Public notices issued. — *b*) Yes. — *c*) We run extra trains. — *d*) Fixed times.

Madras & Southern Mahratta Railway. — *a*) Yes, if there is no accommodation passengers take following ordinary trains. There is a convenient train service on the section. — *c*) If there is sufficient number of passengers, a special is arranged to convey them irrespective of ordinary trains. — *d*) Fixed times.

Question **13**. — *a*) *Is your motor car service for secondary lines limited to runs sandwiched between existing passenger trains.* — *b*) *Whether motor cars are used to meet whole passenger service on certain sections of the railway.* — *c*) *Has this course necessitated running goods trains where mixed trains were formerly run for the conveyance of cattle, etc.*

Furness Railway. — *a*) No. — *b*) No.

Great Central Railway. — *a*) Yes.

Great Western Railway. — *a*) Yes. — *b*) Branches where there are both passenger and goods trains to be dealt with are worked by auto engines, the trailer being disconnected when working the goods trips. — *c*) An automotor car will deal with limited horse milk and cattle traffic (vacuum fitted vehicles) in special cases.

Lancashire & Yorkshire Railway. — *a*) No, in most cases they have entirely superseded the ordinary trains. — *b*) Yes. — *c*) Marchandise and cattle were carried by separate goods train previous to the advent of rail motors, and are still so carried.

London & North Western Railway. — *a*) In four cases, yes, in two cases the whole of the passenger train service is worked by the cars. — *b*) Yes, the cars are used exclusively on two

services. — *c*) The goods services are provided by ordinary goods trains, independently of the passenger car service.

London, Brighton & South Coast Railway. — *a*) In most cases-yes. — *b* and *c*) On one branch, Brighton to Kemptown, the service is worked exclusively by motor trailer car. Goods, cattle, and express goods carried, shunted, etc., by ordinary locomotive and stock.

Midland Railway. — *b*) Nothing has been done in the way of complete services as yet.

North Staffordshire Railway. — *c*) No.

North Eastern Railway. — *a*) No, at present time complete service on one branch line except for the one run to York and back which is run between ordinary trains hauled by locomotives. — *b*) Yes, the service is on a line of this class. — *c*) By the ordinary goods train.

Port Talbot Railway. — *a*) Run as ordinary passenger train.

Rhymney Railway. — *a*) Yes. — *b*) On one branch the complete service during the day time is worked by automotor car. — *c*) No. Vans are attached in the rear of the automotor car as found necessary.

Taff Vale Railway. — *a*) Yes. — *b*) No.

Dublin & South Eastern Railway. — *a*) No. — *b*) Yes. — *c*) No, passenger line only.

Central South African Railways — *a*) Yes. — *b*) The question of using these cars exclusively to deal with branch line passenger traffic has not been considered to date. At present the service is run in connection with and sandwiched between, the ordinary passenger and mixed traffic service.

South Australian Government Railways, — *b*) It is not intended to adopt these vehicles to deal solely with the passenger traffic. — *c*) As the regular goods traffic does not warrant the running of mixed trains daily the cars are being used to deal with the light passenger and mail traffic on alternate days.

Great Indian Peninsula Railway. — *a*) Yes, sandwiched between existing trains. — *b*) No but the matter is under consideration. The motor only becomes economical when there is more work than one engine can do.

Madras & Southern Mahratta Railway. — *a*) No. — *b*) Yes. — *c*) Carried by goods train.

QUESTION 14. — *Is it intended to extend the use of motor cars to meet the competition of tramways or simply to improve existing services where short and frequent stops are necessary.*

Furness Railway. — No.

Great Western Railway. — No additional services proposed at present.

Lancashire & Yorkshire Railway. — No.

London & North Western Railway. — There is no present intention of extending the use of these cars.

London, Brighton & South Coast Railway. — The system of trailer cars is likely to be extended where ever full-sized stock can be superseded for picking up a few passengers and where "halts" can be profitably made, to gather in travellers who would otherwise journey by carrier, road motor, or other competitive form of conveyance. The motor services already enable this class of traveller, and those from unimportant stations to join trains at the chief stopping places conveniently.

Midland Railway. — Our automotor train working is practically confined to local branch traffic ant it is to work this class of traffic at moderate expense that this system has been originated.

North Staffordshire Railway. — No.

North Eastern Railway. — No.

Port Talbot Railway. — Sole object in adopting motor car was economy.

Rhymney Railway. — The motor services will be extended to short branches as they are opened for the purpose of feeding the main line trains.

Taff Vale Railway. — Uncertain.

Dublin & South Eastern Railway. — Yes.

Central South African Railways. — The two motor coaches at present running on our lines are giving satisfaction, in that they provide transportation facilities to the public whose requirements in this direction are not other wise catered for. In inaugurating the services, the object aimed at was not competition with other methods of transport which on the routes taken is non-existent. The motor train service is arranged so as to give the suburban public facilities for joining long distance trains at Pretoria and Germiston. The headquarters of the respective services and to provide travelling facilities for that section of the public who reside along the railway. The question of using this type of vehicle exclusively instead of light passenger trains for branch line service has been considered, but so for no practical application of the idea has been made.

South Australian Government Railways. — No.

Great Indian Peninsula Railway. — As funds permit, we propose to extend our programme. It is possible we may use the cars to feed fast trains and also distribute from fast trains, but our first object will be to provide a more efficient service on short branches.

Madras & Southern Mahratta Railway. — No.

QUESTION 15. — *Is it intended to utilise motor cars on certain sections, as a temporary measure, to ascertain whether the result would justify the running of regular passenger trains.*

Alexandra (Newport) Docks and Railway. — No.

Furness Railway. — No.

Great Western Railway. — The introduction of automotor cars was to give an increased frequency at a moderate expense and to tap new sources of traffic by stopping at suitable intermediate points between stations. No cases of car services being converted into train services, nor of motor service being discontinued.

Lancashire & Yorkshire Railway. — No.

London & North Western Railway. — No.

Midland Railway. — No.

North Staffordshire Railway. — No.

North Eastern Railway. — No.

Taff Vale Railway. — This aspect of the question has not been considered.

Dublin & South Eastern Railway. — No.

Central South African Railways. — The services provided so far have only been on routes where it was known that this class of traffic was offering, and the cars have not been used experimentally as creators of traffic to date.

South Australian Government Railways. — No.

Great Indian Peninsula Railway. — This has been thought of but not given effect to.

Madras & Southern Mahratta Railway. — Yes.

QUESTION 16. — *Are motor cars allotted to sundry local journeys on sections where no trains are run on Sundays, or at Holiday times; and do you use such days for the cleaning of the cars.*

Alexandra (Newport) Docks and Railway. — Yes.

Furness Railway. — No.

Great Western Railway. — No.

Lancashire & Yorkshire Railway. — No.

London & North Western Railway. — These cars are run during the six working days of the week like other local passenger trains only one regular trip is made on Sundays from Walsall to Hednesford and back. The washing out etc. is done during the week nights when the cars are not in service.

Midland Railway. — This has been our general practice.

North Staffordshire Railway. — Yes.

North Eastern Railway. — Allotted to sundry local journeys on sections where no trains are run on Sundays.

Rhymney Railway. — The cars are not booked to run on Sundays and public holidays. Yes.

Taff Vale Railway. — Some services are run with motor cars on Sundays and others with trains, and we wash out and do shed repairs to as many as can be dealt with on Sunday.

Dublin & South Eastern Railway. — No.

Central South African Railways. — The journeys allotted to these cars are arranged to suit the needs of the public and exigencies of the heavier traffic. There is a fixed service for all week-days and another for Sundays, and these are not altered for special occasions. As the cars run on a day service only, washing out and ordinary light repairs can be effected at night.

South Australian Government Railways. — Apart from the ordinary journeys, these cars may be hired for picnic parties, etc. As the cars do not run a daily service, the off days allow sufficient time for repairs, etc.

Great Indian Peninsula Railway. — Motor car does run on Sundays. The cars run when the traffic is lightest, *i. e.* in the middle of the day.

QUESTION 17. — *Are motor cars stabled in the locomotive sheds or are separate sheds provided, worked by a special staff.*

Alexandra (Newport) Docks and Railway. — We have a separate shed for the cars. No special staff employed.

Furness Railway. — Stored in carriage stock shed on station siding. Same staff used as for locomotives.

Great Western Railway. — Separate sheds in two cases only. Same staffs as for locomotives.

Lancashire & Yorkshire Railway. — Yes. The rail motor is maintained by the engine shed staff. The carriage is maintained by the carriage department staff.

London & North Western Railway. — They are kept in the same sheds as our locomotives, and are attended to by the ordinary staff.

London, Brighton & South Coast Railway. — Class 1 : The engines are detached from trailer car and make shed as ordinary. The car is sided with regular stock. — Class 2 : Engines and cars shed in ordinary steam shed. — Classes 3 and 4 : Stand at end of dock platforms at Brighton Station only.

Midland Railway. — No special sheds are provided.

North Staffordshire Railway. — Rail motor cars are stabled in a separate shed but same staff look after these cars that attend to the locomotives, the rail motor shed being alongside the running shed.

North Eastern Railway. — No. Stood in open and dealt with by special staff.

Rhymney Railway. — Yes. By the same staff.

South Eastern & Chatham Railway. — Automotor cars as a rule are kept in the same sheds as the locomotives.

Taff Vale Railway. — Yes. Worked by the same staff.

Dublin & South Eastern Railway. — Locomotives separated for stabling.

Great Northern Railway (Ireland). — Separate shed and a special staff.

Central South African Railways. — These cars are stored in the same sheds as the Main Line Locomotives, and are dependent on the ordinary running shed, staff for up-keep and light repairs.

South Australian Government Railways. — The same staff attend to the motor cars as to the locomotives, but they are not stabled in the same sheds.

Great Indian Peninsula Railway. — Usually stabled in locomotive shed.

Madras & Southern Mahratta Railway. — Yes. Same staff used as for locomotives (no separate shed).

North Western State Railway of India. — Only one car on the system. Car kept in locomotive shed. No special staff kept for it.

Section III. — **Technical and economical results.**

Question **1.** — *What is the maximum distance run in regular service without taking water or fuel.*

Furness Railway. — With stopping train 20 miles.

Great Western Railway. — About 30 miles. Water capacity not provided for longer distances.

Lancashire & Yorkshire Railway. — Distance run without stopping. Double barrel type : For fuel, 50 miles ; for water, 38 miles. — Locomotive boiler type : For fuel, 100 miles ; for water, 38 miles.

London & North Western Railway. — 20 miles.

London, Brighton & South Coast Railway. — The steam cars can run a distance totalling up to 50 miles on coal and water carried. Circumstances allow of the maximum run between replenishments being not more than 22 miles.

Midland Railway. — With one of our automotors the journey from Derby to London has been run without taking on any extra coal and with two extra supplies of water only. Distance 127 miles.

North Staffordshire Railway. — From 14 to 20 miles with the supply of water carried by our cars, according to the part of the line being worked over, *i. e.* level or otherwise.

North Eastern Railway. — 240 miles.

Port Talbot Railway. — 35 to 40 miles without taking water. 125 miles without taking coal.

Rhymney Railway. — The motors run on an average 650 miles per week.

Taff Vale Railway. — 100 to 130 miles per day for coal. Water about 40 miles.

Dublin & South Eastern Railway. — 70 miles.

Central South African Railways. — Class 1 : The coal bunker on the engine of this car has a capacity of 1 1/2 tons sufficient for a 120 miles run, and 550 gallons of water are carried in the side tanks sufficient for 40 miles.

South Australian Government Railways. — Class 2 : The coal bunker on the engine of this car has a capacity of 1 1/8 tons sufficient for a run of 100 miles and 500 gallons of water are carried in the side tanks sufficient for a 35 mile run.

South Australian Government Railways. — These cars carry sufficient coal and water for a journey of from 25 to 30 miles.

Great Indian Peninsula Railway. — A 20 mile run with 6 cwt. of coal and 350 gallons of water.

Madras & Southern Mahratta Railway. — 25 miles.

North Western State Railway of India. — 30 miles approximately.

QUESTION 2. — *Does it take longer to "water" these cars than an ordinary locomotive and have you found it necessary to adopt special appliances for this purpose?*

Alexandra (Newport) Docks and Railway. — No. We make use of the same hydraulic cranes for the cars and locomotives.

Furness Railway. — Slightly longer time. Same water crane as used for locomotives.

Great Western Railway. — No. Same water arrangements as locomotives.

Lancashire & Yorkshire Railway. — Ordinary locomotive hydrants will suit, but special hydrants have been fixed for rail motors at starting places in order to save shunting time, etc.

London & North Western Railway. — We do not take in water at intermediate stations. The boiler and tanks are filled up at the terminal stations by means of a hose pipe coupled to a water hydrant.

London Brighton & South Coast Railway. — The engines feed from the standard cranes.

Midland Railway. — Special tundish carried on car to receive water from feed pipe but otherwise no special arrangement, *i. e.* hydrants or cranes.

North Staffordshire Railway. — No the tank lids are of ordinary dimensions so that a water column hose bag can be used as on locomotives.

North Eastern Railway. — Water supply sufficient for one week.

Port Talbot Railway. — No special fittings used.

Rhymney Railway. — The same hydrants are in use with the motors as with engines. We find the motors are no longer taking water than the engines.

Taff Vale Railway. — About the same time. Yes — but it was to facilitate dispatch of traffic working and the cranes used by the locomotives are made use of.

Dublin & South Eastern Railway. — No.

Great Northern Railway (Ireland). — No.

Central South African Railways. — The water tanks on the locomotives of these cars are filled from the standard locomotive water colums.

South Australian Government Railways. — About the same times are allowed as for the locomotives and the same appliances used.

Great Indian Peninsula Railway. — We use the ordinary cranes but had to cu a larger hole in cab plate to allow hose to enter. Filling does not take longer than other tank engines.

Madras & Southern Mahratta Railway. — No.

North Western State Railway of India. — No watering at intermediate stations.

QUESTION 3. — *What are the most difficult performances that have been carried out as regards effort af traction, working of boilers, speed attained over varying grades, etc., and maximum speed and acceleration speed on level.*

Alexandra (Newport) Docks and Railway. — No records.

Furness Railway. — The most difficult performance is the service on which the car is now running; given in II, Nos. 7, 8 and 9.

Great Western Railway. — No special tests made. Ordinary acceleration on level 30 miles per hour in 30 seconds.

Lancashire & Yorkshire Railway. — The most difficult performance is when a car is being hauled from Bury to Holcombe Brook. Average gradient 1 in 50. Length of journey 3 miles 408 yards. Maximum gradient, 1 in 40. Length of journey for maximum gradient, ½ mile. Maximum journey without stop, 3 miles 352 yards. Average booked speed for same 8 minutes. Maximum speed on level 40 miles per hour.

London & North Western Railway. — See gradient sheets shewing the gradients on the Prestatyn and Dyserth Branch which are the steepest we have to work over with these cars. Prestatyn to Rhyl, 28 miles per hour.

Midland Railway. — A speed of 70 miles per hour has been attained on a down gradient of 1 in 300 but 60 miles per hour can be attained on level road : these results are obtained with no trailers. 45 miles per hour has been reached with 4 10-ton guard's brakes on level. Maximum journey without stops has been 40 miles done in 55 minutes with the car only, no trailers. With 12- loaded wagons (10 tons each) have been pushed up a gradient of 1 in 120 in the ordinary through goods time.

North Staffordshire Railway. — Our journeys are short ones, but you will see by the profile that gradients of 1 in 34, 1 in 50, 1 in 66, 1 in 82, etc., are negociated but the engine has to be thrashed in some cases to keep time. About 40 miles per hour.

North Eastern Railway. — Average 28 miles per hour. Maximum 35 miles per hour. Full speed in 2 3/4 minutes.

Port Talbot Railway. — Never tried more than one trailer.

Rhymney Railway. — 40 miles per hour.

South Eastern & Chatham Railway. — 40 miles per hour. 30 miles per hour in half a minute.

Taff Vale Railway. — Starting on gradients of 1 in 40. Boiler gives no trouble. 1 in 40 varying 1/2 mile to 1 mile. 30 miles per hour. 30 miles per hour in 30 seconds.

Dublin & South Eastern Railway. — Service is 6 miles run in 20 minutes with six intermediate stops hauling 3 cars weighing 53 tons. Line practically level. Average speed 18 miles per hour including stops. A speed of 38 miles is attained between stations. 35 miles per hour. 20 miles per hour in 30 seconds.

Central South African Railways. — No special experiments have been made with either of these cars as regards speed load or stability. Number 1 car is much steadier in running than No. 2 car and affords more comfort for passengers. No. 2 having the engine and coach on the one framework makes the whole vehicle to ride very roughly, consequently No. 1 car can be run at a higher speed than No. 2 car without excessive vibration or rolling.

South Australian Government Railways. — The heaviest work these motors are called upon to do is in running over the length of line shewn on figure 40 at an average speed of 17 miles per hour. Maximum speed on the level 31 miles per hour.

North Western State Railway of India. — 44 miles an hour working light on trial trip.

QUESTION 4. — *What difficulties, if any, have you experienced in regular working. Have you found it difficult to keep to timetable and can you make up for any time lost on journey.*

Alexandra (Newport) Docks and Railway. — No.

Furness Railway. — No difficulties have been experienced.

Great Western Railway. — No difficulty in meeting the requirements of the various services. Not the practice to make good in running the time lost at stations, but the times at terminals is reduced.

Lancashire & Yorkshire Railway. — The engines are of sufficient power to handle the loads they have to work satisfactorily and maintain the booked services. In some cases where the speeds are comparatively low, time can be regained between stations.

London & North Western Railway. — The engine is sufficiently powerful for its purpose and in every other respect is satisfactory. Time can be made up if required.

Midland Railway. — With regard to the regularity of travelling and time table working, no difficulty has been experienced.

North Staffordshire Railway. — Our rail motors work very well especially when not hauling a trailer coach but on some parts of our line we do not find it an easy matter to keep time when a trailer is attached, and consequently it is not often that we can make up for loss of time.

North Eastern Railway. — Power sufficient for the service. Smoothness very good. No difficulty in keeping to the scheduled time under ordinary conditions, but under adverse conditions power insufficient to allow of loss being made up.

Rhymney Railway. — No loss of time.

Taff Vale Railway. — The working is satisfactory. A vehicle runs smoother when separate from the motor. No difficulty. Time can be made up.

Dublin & South Eastern Railway. — No difficulties have arisen in working. Time can be made up.

Central South African Railways. — When working normally the locomotive power on these cars has proved sufficient to run the services to time under all conditions of weather, etc.

South Australian Government Railways. — On the whole the results are considered satisfactory.

Great Indian Peninsula Railway. — No difficulty. Time can be made up but to only a very small margin.

Madras & Southern Mahratta Railway. — Runs generally to time. If time is lost there is possibility of making it up.

North Western State Railway of India. — No. Booked at 26 miles per hour. Time can be made up.

Question 5. — *a) Have you found any difficulties in the upkeep of the boiler, or the automotor having regard to the more delicate construction than that of an ordinary locomotive. — b) Has the boiler given trouble on account of the quality of the water used. — c) Do you keep spare motor trucks or engines to replace engines failing or requiring repairs.*

Alexandra (Newport) Docks and Railway. — *a*) No. — *b*) No. — *c*) No.

Furness Railway. — *a*) No. — *b*) No. — *c*) No.

Great Western Railway. — *a*) No especial difficulties after experimental stage. — *b*) Trouble only to the same degree as with locomotive boilers. — *c*) Yes.

Lancashire & Yorkshire Railway. — *a*) Difficulties have been experienced with the two-barrel type only. — *b*) No more trouble than previously with the ordinary engines. — *c*) No.

London & North Western Railway. — *a*) No. — *b*) We have had to soften the water at two stations for the use of two of the cars. — *c*) These trucks containing the engine and boiler and mechanism complete can readily and easily be changed, and thereby the car itself can be kept in continuous service and not required to stand idle while the engine is under repairs. One spare engine complete is provided for the purpose.

London, Brighton & South Coast Railway. — *a*) The engines have given no more trouble either as to boiler or engine details. In fact the repair account for them is lighter. — *b*) Not more than with the large types. — *c*) No.

Midland Railway. — *a*) A vertical fire tube boiler was originally fixed, but this was not satisfactory for steam raising. This has been replaced by a locomotive boiler and the results are now quite good. — *b*) No special trouble has been experienced with regard to the water used. — *c*) No spare trucks are kept.

North Staffordshire Railway. — *a*) No very serious difficulties. — *b*) The water we generally use for the rail motors is fairly good, but when giving the vehicle general repairs we have had to take several of the bottom rows of tubes out to clear the scale out of the boiler barrel and around the tubes. — *c*) No.

North Eastern Railway. — *a*) No. — *b*) No. — *c*) Yes.

Port Talbot Railway. — *a*) No. — *b*) No. — *c*) No.

Rhymney Railway. — *a*) No. — *b*) No. — *c*) No.

South Eastern & Chatham Railway. — *c*) We do not keep spare motor trucks.

Taff Vale Railway. — *a*) No. — *b*) Yes our water incrustates badly. — *c*) We have two spare motor engines.

Dublin & South Eastern Railway. — *a*) No. — *b*) No. — *c*) No.

Great Northern Railway (Ireland). — No spare parts.

Central South African Railways. — *a*) No particular difficulties have been experienced in service with the boilers or engines of our cars. — *b*) No boiler trouble attributable to the water used. — *c*) Spare motors not provided. When it becomes necessary to take a car out of service for shop repairs, a small locomotive and a coach of suitable design is put on the work.

South Australian Government Railways. — *a*) No. — *c*) Spare wheels and axles are kept in stock.

Great Indian Peninsula Railway. — *c*) No.

Madras & Southern Mahratta Railway. — *b*) Yes. — *c*) No.

North Western State Railway of India. — *a*) No. — *b*) No. — *c*) No.

QUESTION 6. — *a) Do you find that cars if stabled in locomotive sheds suffer deterioration in the upholstering and accessories through any difficulty in keeping them in a good state of cleanliness and. — b) Have they proved in any way an incumbrance at the depots.*

Alexandra (Newport) Docks and Railway. — *a*) We have a separate shed for cars. — *b*) No.

Furness Railway. — *a*) Cars are not stored in locomotive shed with a view to avoiding these troubles. — *b*) Yes.

Great Central Railway. — *a*) No.

*

Great Western Railway. — *a*) No deterioration of body of car, upholstering, etc., that could be attributed to the cars stabling in the same shed as locomotives or to the fact that the mechanical portion is attached to the car. — *b*) No complaint as to cleanliness. No delays or special difficulties owing to locomotive depots being used by cars.

Lancashire & Yorkshire Railway. — *a*) No. — *b*) The additional room required has on occasions caused inconvenience at sheds.

London & North Western Railway. — *a*) No trouble whatever. — *b*) No.

London, Brighton & South Coast Railway. — *a*) The trouble in class 1 is met by detaching the car, the engine going to shed in ordinary way after putting the coach away in siding, or dock in stations. — In class 2, the seats are covered in split cane and the cars being run on branches where the engines making shed are not many, no trouble has so far arisen.

Midland Railway. — *a*) The difficulties of maintenance in repairs and cleanliness of these cars are somewhat enhanced by the fact that there is generally no shed accommodation for them, but as we have no great number of this class of motor, they have not proved to be a special encumbrance to the depots.

North Staffordshire Railway. — *a*) Having a separate shed for the motor cars we are not much troubled in this way. — *b*) Our cars are not very long ones so that not much trouble is experienced.

North Eastern Railway. — *a*) No. — *b*) No.

Port Talbot Railway. — *a*) We have experienced no trouble this way, as we stable the motor and car in the carriage shed, a smoke ventilator being fixed in the roof.

Rhymney Railway. — *a*) No. — *b*) No.

Taff Vale Railway. — *a*) The chief deterioration is the swelling of the mahogany panels due to moist steam which affects the glue and results in drawing the panel pins securing the panels. — *b*) Yes they take up a lot of room.

Dublin & South Eastern Railway. — *b*) No.

Great Northern Railway (Ireland). — *a*) No. — *b*) No, as special sheds are provided.

Central South African Railways. — *a*) The design and arrangement of our cars is such, that though stored in the locomotive running sheds, rapid deterioration of the upholstery and accessories does not take place. — *b*) The extreme length of the cars has given no trouble at the locomotive depots, but as regards light repairs to the coach itself in the steam sheds, it has been found inconvenient and costly, as men have to be brought from a workshop, strict supervision being impossible.

South Australian Government Railways. — *a*) No. — *b*) No.

Madras & Southern Mahratta Railway. — *a*) No. — *b*) No.

North Western State Railway of India. — *a*) No. — *b*) No.

QUESTION 7. — *Have you often found it necessary to replace the automotor cars by ordinary engines and trains when traffic is heavy on holidays, etc., and in cases of breakdown of the cars.*

Alexandra (Newport) Docks and Railway. — No; but we have run supplementary trains worked by locomotive when specially needed.

Furness Railway. — Yes.

Great Central Railway. — Yes.

Great Western Railway. — Rarely.

Lancashire & Yorkshire Railway. — In two cases, the service on Saturday afternoons is worked by locomotives and ordinary carriages owing to the heavy traffic, but on the other branches, this is an unusual occurrence. Mishaps occasionally occur and on such occasions another car is brought into use when one is available, but if another car is not at liberty, an ordinary steam train is run.

London & North Western Railway. — No.

London, Brighton & South Coast Railway. — An extra coach is attached on such occasions alternately to the engine or motor coach according to the direction run.

Midland Railway. — This question has been partly auswered, see II-12. In case of accident, an ordinary train is substituted for the car.

North Staffordshire Railway. — At holiday times chiefly, we have to set aside the cars from their ordinary working but we sometimes use them on these occasions to run between trains to carry passengers from place to place.

North Eastern Railway. — Not at all. Second car brought into use when necessary.

Rhymney Railway. — On bank holidays, fete days etc., when there is a great rush of passengers, the motor cars are put aside, replacing them by trains hauled by locomotives.

Taff Vale Railway. — Occasionally but not often.

Dublin & South Eastern Railway. — Yes.

Central South African Railways. — The number of passengers offering on the routes served by our cars is more or less constant. It has not been found necessary to make extraordinary arrangements for passenger rushes.

South Australian Government Railways. — It has at times been found necessary to replace these motors with trains, but not often.

Madras & Southern Mahratta Railway. — Motor cars are run independent of other ordinary trains to booked timings and are not cancelled in cases of heavy rush of passengers.

North Western State Railway of India. — Yes.

QUESTION 8. — *Have you found any advantage in reducing classes to one only even for trailing cars.*

Alexandra (Newport) Docks & Railway. — Always had one class.

Furness Railway. — No.

Great Central Railway. — No.

Great Western Railway. — One class only used. Advantage in seating.

London & North Western Railway. — No : no trailing cars used.

London, Brighton & South Coast Railway. — All the motor cars, trailer and otherwise, are one class only, and no disadvantage of any kind has become apparent.

North Staffordshire Railway. — It simplifies matters to some extent, and we find that 3rd class accommodation is that mostly required. When we run a trailer coach, it is one with 1st and 2nd class accommodation usually.

Rhymney Railway. — Third class only is carried in the motor cars, also in the trailing cars. This is found advantageous as the 3rd class passengers are numerous in the district where the cars run.

Taff Vale Railway. — We find it best to have two *viz.* : 1st and 3rd.

Dublin & South Eastern Railway. — Have not reduced the classes to one.

Central South African Railways. — One of these cars has one class only; the other, two classes. Routes are allocated to these cars to suit the class of accomodation required.

South Australian Government Railways. — It has not been tried.

Great Indian Peninsula Railway. — Two classes instead of three are available. No advantage beyond that it would have been impossible to have accommodated 3 classes economically in the limited space.

Madras & Southern Mahratta Railway. — No.

QUESTION 9. — *Has the number of automotor car journeys sandwiched between existing passenger trains caused obstructions or delays, particularly on sections of the line over which express trains are run.*

Alexandra (Newport) Docks & Railway. — No.

Great Central Railway. — To some extent.

Great Western Railway. — No.

Lancashire & Yorkshire Railway. — No. The services are timed so as not to obstruct other trains.

London & North Western Railway. — No.

London, Brighton & South Coast Railway. — No.

Midland Railway. — No.

North Staffordshire Railway. — No.

North Eastern Railway. — No.

Rhymney Railway. — No.

Taff Vale Railway. — On crowded sections of the line-yes.

Dublin & South Eastern Railway. — No.

Central South African Railways. — The motor train services are arranged with reference to the ordinary traffic in such a manner as to obviate the possibility of any disruption of the general traffic working.

South Australian Government Railways. — No.

Great Indian Peninsula Railway. — Not so long as they run to time.

Madras & Southern Mahratta Railway. — No, our motor service is limited.

QUESTION 10. — *Average consumption of fuel per mile including consumption for lighting and stoppages.*

Alexandra (Newport) Docks and Railways. — 12·37 lb. per mile.

Furness Railway. — 28 lb. per mile.

Great Western Railway. — 18 lb.

Lancashire & Yorkshire Railway. — 27·23 lb.

London & North Western Railway. — 24·38 lb. per train-mile.

London, Brighton & South Coast Railway. — Class 1 : 16·4 lb. — Class 2 : 14·5 lb. — Class 3 : 1.82 pints of spirit.

Midland Railway. — Class 2 : 30·05 lb. of coal. — Class 3 : 37 lb. of coal.

North Staffordshire Railway. — 26 lb.

North Eastern Railway. — 3 1/2 miles per gallon of petrol or 28 gallons per mile.

Port Talbot Railway. — 16·3 lb.

Rhymney Railway. — Average consumption of coal per mile 20 ?5 lb. taken over 6 months.

Taff Vale Railway. — Average 23 3/4 pounds. Large cars, 26 lb. Small cars, 22 1/2 lb.

Dublin & South Eastern Railway. — 24 lb. of South Wales coal per mile.

Central South African Railways. — 28 3 lb. per mile.

South Australian Government Railways. — 14 lb. per mile.

Great Indian Peninsula Railway. — 41·76 lb. per mile.

Madras & Southern Mahratta Railway. — 33 lb.

North Western State Railway of India. — 21 lb. per mile.

RAILWAY.	QUESTION 11. — *Average cost per mile for greasing, lighting, water, traction staff, cleaning, upkeep of mechanical part and of car.*								
	Oiling.	Greasing.	Lighting.	Water.	Traction staff.	Cleaning.	Mechanical part.	Car.	Total.
	Pence.	Pence.	Pence.	Pence.	Pence.	Pence.	Pence.	Pence.	Pence.
Alexandra (Newport) Docks and Railway.	...	0·027	...	...	1·8	0·364	0·758	0·866	...
Furness Railway	...	...	...	...	...	...	...	...	5·89
Great Western Railway	...	...	...	...	...	...	...	...	8·0
London & North Western Railway	...	...	...	...	...	...	...	...	4·37
London, Brighton & South Coast Railway — Class 1.	...	...	...	...	...	...	...	...	3·98
London, Brighton & South Coast Railway — Class 2.	...	...	...	...	...	...	...	...	4·63
London, Brighton & South Coast Railway — Class 3.	...	...	...	...	...	...	...	...	9·23
Midland Railway — Class 1.	0·13	...	...	...	3·69	0·13	...	...	...
Midland Railway — Class 2.	0·11	...	...	0·14	1·7	0·1	...	...	...
Midland Railway — Class 3.	0·15	...	...	0·18	1·08	0·08	...	...	...
North Eastern Railway	...	...	...	...	...	...	...	...	5·299
Rhymney Railway	...	...	...	...	...	...	...	...	4·4
Taff Vale Railway	...	...	...	...	...	...	...	...	8·71
Dublin & South Eastern Railway	...	1s. per 1,000 miles	1/2d. per mile	6·0 per 100 miles	1 3/4		1·0	0·27	...
Central South African Railways. — Class 1.	...	0·096	0·002	0·024	4·713	0·211	0·510		...
Central South African Railways. — Class 2.	...	0 072	0·001	0·397	4·532	0·196	1·343		...
South Australian Government Railways	...	...	...	...	...	...	...	...	10·0
Great Indian Peninsula Railway.	...	...	...	...	...	...	...	...	1·05 Annas.
North Western State Railway of India	...	...	...	...	...	...	...	...	3·0 —

QUESTION 12. — *Data similar to those asked for by the questions Nos.* 10 *and* 11 *for the small locomotives dealt with at questions* 1-13 *or for the ordinary tender locomotive dealt with at question* 1-14.

Taff Vale Railway. — Coal 38 pounds per train mile. 8·025 pence per train mile including renewal charges but exclusive of cost for carriages.

South Australian Government Railways. — Class Z average consumption per mile 32 lb. Average cost per mile 13·17 pence.

QUESTION 13. — *Average price of the automotor cars for your various types in comparison with the price of the locomotive dealt with in the foregoing questions.*

Furness Railway. — £2,328.

Great Western Railway. — Motor car £2,000. Small engine (estimated) £1,600. We have not constructed any of the small engines for many years.

London & North Western Railway. — Average cost £2,000.

Midland Railway. — Class 1 : C. & W. work £736. Locomotive work (only) £1,000. — Class 2 : tank engine (estimated when new) £1,600. Now adopted for automotor work. — Class 3 : tank engine £2,365. Now adopted for automotor work.

North Staffordshire Railway. — The price of our rail motors averaged about £2,000 each.

North Eastern Railway. — Cost of automotor cars about £3,000 each.

Rhymney Railway. — Cost of steam motor car £3,250.

Taff Vale Railway. — Large cars £2,380 each. Small cars £2,069 each.

Dublin & South Eastern Railway. — £2,780.

Central South African Railways. — Class 1 : this car consists of a side door suburban coach whose original cost was £2,401 converted to suit this class of traffic, such conversion costing £1,710 for both engine and coach. The engine was reclaimed from scrap. Its cost new was £1,715. — Class 2 : £4,653·12*s.* 8*d.*

South Australian Government Railways. — Motor car £2,311. Passenger engine £2,976.

Madras & Southern Mahratta Railway. — 29,071 rupees.

North Western State Railway of India. — 35,000 rupees approximately.

QUESTION 14. — *Have you other automotor cars building? Of what type? Do you intend extending the use of them?*

Furness Railway. — No, Not at present.

Great Central Railway. — No.

Great Western Railway. — None building at present.

Lancashire & Yorkshire Railway. — No.

London & North Western Railway. — We have none building at present. No.

London, Brigton & South Coast Railway. — Other engines of the small type will be converted for trailer service as they pass through the shops.

Midland Railway. — No other cars building.

North Staffordshire Railway. — No.

North Eastern Railway. — No.

Port Talbot Railway. — No. We do not intend extending the use of them.

Rhymney Railway. — The Company have no motor cars now building and do not require more cars at present and therefore have not considered the question.

Taff Vale Railway. — No.

Dublin & South Eastern Railway. — No.

Great Northern Railway (Ireland). — No.

Central South African Railways. — We are not at present building more cars of either type but we are considering the design for a car for branch lines, the type to follow closely No 1 motor *viz.* : a small locomotive attached to a specially designed coach. This type of car has many advantages over those of the No. 2 motor type and the design of all future cars added to our stock will probably in the main follow that of this car. The self contained type of car such as motor No. 2 is not satisfactory, especially as regards confort for passengers, ease of detachment, and complication and number of spare parts. The latter point is important, in so far that very few of the parts of the self-contained car can be made interchangeable with those on ordinary rolling stock.

South Australian Government Railways. — No.

Great Indian Peninsula Railway. — No. When the service is extended, it will be by the adoption of small locomotives passed service for regular traffic.

Madras & Southern Mahratta Railway. — No.

North Western State Railway of India. — No.

APPENDIX II.

Reply of the North Eastern Railway (England).

QUESTIONS 1 to 11. — *Rail auto-motor cars.*

The driving power provided consists of a four cylinder horizontal petrol engine, built by the Wolseley Tool and Motor Car Company, of Adderley Park, Birmingham, and rated at 80 B. H. P. at 420 R. P. M.

This drives a compound wound and separately excited dynamo rated at 55 kilowatts, which supplies current to two 60 H. P. B. T. H. tramway and motors mounted on the front bogie of the car.

With the exception of these motors, the whole of the electrical equipment was supplied by the British Westinghouse Electrical & Manufacturing Company, Trafford Park, Manchester.

The petrol motor has cylinders 8 1/2 inches diameter, by 10 inches stroke, and is designed for a normal speed of 420 R. P. M. but can be accelerated to 480 R. P. M,, and this is done in getting the car under way. The crankshaft, of the "two throw" pattern is constructed of Vickers-Maxim cast steel. The cranks are, of course, completely enclosed, the inspection covers of the casing being at the top, and an oil trough below. Two cylinders placed vis-a-vis drive on to each crank. There are two cam-shafts, one on each side of the engine, and the whole of the valves are mechanically operated.

The cylinders and valve boxes are water jacketed, the temperature of the circulating water being kept down by a Clarkson Radiator cooled by the blast from a Blackman fan.

The armature of the generator is mounted on an extension of the crankshaft and there is a 3 feet flywheel between the armature and the engine casing. This generator is compound wound, and separately excited, and is specially designed for operating over a range of 300 to 500 volts. The field is split horizontally, so that the upper portion may be removed through an opening in the roof of the car when access to the armature is desired. The exciter is driven by belting from a pulley on the outer end of the generator shaft. This exciter is shunt wound, and is used also for running the 30, 16 C. P. power, 72 volt electric lamps with which the car is lighted, and can further be used to furnish current at 95 volts, for changing a secondary battery of 38 cells, each rated at 120 ampere hours, which is fixed beneath the floor of the car. The whole of the generating plant is fixed in the front compartment of the car, which is 13 ft. 3 in. long.

The controllers are of the standard pattern (tramway type) and one is fitted at each end of the car.

In starting up, the engine is driven, for a turn or two, by the generator acting as a motor and taking current from the secondary battery. Once the engine is up to speed, and the voltage has been adjusted to 400 volts, the car is started by the controller in the usual way. For slow speeds the car is run with the motors in series and for high speeds with them in parallel. The

voltage of the generator is gradually increased to 500 volts, by cutting resistances out of the exciter circuit and the car will then accelerate until a speed of 35 miles per hour is attained. In stopping the car, the controller handle is moved back to the off position and then over in the reverse direction to apply the Westinghouse track brakes, with which the car is provided. These consist of two electro-magnets suspended between the wheels. When the magnets are excited, the shoe with which they are provided is attracted on to the rail, thus acting as a track brake.

At the same time, the downward motion of the magnets also applies brake shoes to the wheels, and a further retarding action is attained through the fact that the current for these magnets is obtained from the motors acting as dynamos, so that the brake does not depend for its current on the generator plant.

The cars are very comfortably fitted up. There is a gangway between the two rows of reversible seats, and the floor is covered with linoleum.

Each car is fitted with buffers and coupling hooks of the standard railway carriage pattern, so that it can be run with the ordinary rolling stock if necessary.

The time taken to get ready for work is only 10 minutes and a full days supply of petrol is carried.

QUESTIONS **1** to **13.** — *Steam autocars.*

The railway companies are now finding the advantage of having a number of self-propelled coaches to supplement the ordinary train service in times of heavy traffic, or to work on branch lines between stations where the traffic is not sufficient to warrant the cost incurred by running ordinary passenger trains.

Several companies have built special vehicles with a small steam engine driving on one bogie, but the North Eastern Railway Company, having a number of small passenger tank engines which are not powerful enough to cope with normal present day trains, determined to utilise these for similar purposes, and thus save the expense of building a combined vehicle. For this purpose, the engine is coupled up to an ordinary carriage slightly altered. The exterior view is shown on the enclosed photo. The reversing screw and regulator handle are coupled up by means of sprocket wheels and chains to two small shafts under the buffer beam of the engine; they are provided with universal joints and telescopic movement on account of curves, etc., and extending under the coach underframe to the other end where they are coupled up to handles similar to those a driver is used to on a locomotive. These are placed in a compartment at the front end of the coach, which also contains the Westinghouse Brake drivers handle connected with the main air reservoir on the locomotive. When the engine is leading, the driver is in his normal position with the fireman, but when running in the opposite direction he communicates with him by means of a speaking tube. In the event of a failure on the locomotive, when the driver is not on the foot-plate, the auxiliary driving gear is so arranged that it can be thrown out of action and the locomotive stopped by the fireman. The idea has been further developed on some sections, and the engine being placed between two of these fitted coaches, in each of which is a drivers compartment.

A great many of these "steam autocars" are now running.

APPENDIX III.

Time-Tables.

NAME OF RAILWAY	Points between which cars are run.		Distance. M.	C.	Intermediate stops.	Number of cars daily employed.
Alexandra (Newport) Docks and Railway. . .	Pontypridd	Caerphilly	6	40	7	2
Furness Railway	Coniston.	Foxfield	9	60	3	1
	Wrexham	Brymbo	5	44	5	...
	St. Helens	Lowton St. Marys . .	8	36	3	...
	Wigan.	St. Helens.	18	61	10	...
Great Central Railway	Lowton St. Marys . .	Wigan.	6	17	4	...
	Woodford	Banbury	11	13	...	1
	Aylesbury	Verny Junction . . .	12	34	4	1
	Aylesbury	Princes' Risboro' . .	7	20	1	...
	Exeter St. Thomas. .	Teignmouth	14	9	4	1
	Brent	St. Germans.	26	55	20	
	Lipson Vale	Yealmpton.	7	75	7	6
	Tavistock Junction .	Plym. Bridge	1	59	2	
	Truro	Penzance	25	67	10	
	Blackwater Jn. East.	Newquay	18	7	12	5
	Gwinear Road. . . .	Helston	8	67	4	
	Swansea E. D.	British Rhondda . .	17	21	9	2
	Aberystwyth.	Lampeter	28	60	8	2
	Narberth	Pembroke Dock . . .	22	12	8	3
Great Western Railway.	Tenby	Fishguard	39	22	8	2
	Black Lion Crossing.	Cwmaman	2	56	4	2
	Merthyr	Magor	33	26	12	2
	Chalford.	Stonehouse	6	76	8	2
	Swindon	Cirencester . . .	17	75	3	1
	Chippenham	Bristol.	24	31	9	
	Bristol.	Portishead.	11	47	5	
	Bristol.	Chipping Sodbury . .	13	3	8	
	Filton	Pilning	4	60	2	9
	Bathampton	Taunton	52	48	19	
	Westbury	Salisbury	24	44	7	
	Westbury	Patney.	14	38	3	

NAME OF RAILWAY	Points between which cars are run.		Distance.		Intermediate stops.	Number of cars daily employed.
			M.	C.		
	Durston	Bridgewater	5	62	2	
	Calne	Bradford S. Junction.	16	6	9	9
	Holt Junction	Patney via Devizes	13	0	3	
	Weymouth	Dorchester	6	72	4	2
	Upwey Junction	Abbotsbury	6	9	4	
	Cheltenham	Honeybourne	21	47	10	3
	Moreton	Evesham	15	9	6	
	Southall	Paddington	9	6	5	
	Acton	Willesden	1	42	2	
	Victoria	Gerrards Cross	22	29	17	
	Ealing	Greenford	2	52	2	5
	Denham	Uxbridge	2	53	1	
	Battersea	Clapham Junction	1	5	1	
	Southall	Brentford	3	77	2	
	Chester	Oswestry	26	55	11	
	Ruabon	Corwen	16	25	8	
	Wrexham	Berwig	6	62	8	
Great Western Railway. (*Continued.*)	Moss Valley Junction	Moss	1	78	4	9
	Rhos Junction	Wynn Hall	...	...	7	
	Legacy	Ponkey	1	39	3	
	Worcester	Wolverhampton	33	39	18	
	Hartlebury	Bridgenorth	18	6	6	
	Kidderminster	Woofferton	24	10	12	
	Stourbridge Junction.	Stourbridge Town	0	59	1	9
	Stourbridge Junction.	Old Hill	4	11	3	
	Netherton	Halesowen	4	23	6	
	Birmingham	Stratford	24	75	15	
	Tyxley	Henley-in Arden	13	39	6	8
	Rowington Junction.	Bearley via Hatton	7	55	2	
	Pontardulais	G. C. Garwen	10	66	8	2
	Princes Risboro	Heyford	32	66	16	
	Oxford	Shipton	18	21	4	3
	Kidlington	Blenheim	3	56	...	
	Port Talbot	Blaengarw	17	40	9	1
	Paddington	Uxbridge	15	78	10	2
	Southall	Brentford	3	31	1	

NAME OF RAILWAY	Points between which cars are run.		Distance.		Intermediate stops.	Number of cars daily employed.
			M.	C.		
Great Western Railway. (*Continued.*)	Watlington	Princes Risboro	8	74	5	1
	Banbury	C. Norton Junction	23	52	8	1
	Chippenham	Colne	5	44	1	1
	Chippenham	Bath	12	72	4	
	Bathampton	Trowbridge	10	34	5	
	Bradford S.	Thingley Junction	8	29	0	
	Newnham	Drybrook	15	8	10	1
	Weymouth	Abbotsbury	8	31	5	1
	Laira	Wearde	8	11	4	1
	Lipson Vale	Yealmpton	7	75	6	
	Laira Junction	Tavistock	13	63	8	
	Stratford	Lapworth	12	74	4	
	Bearley	Hatton	5	0	1	1
	Pershore	Stratford	19	6	9	
	Leamington	Hatton	6	10	...	
	Wrexham	Berwig	6	6	7	1
	Stourbridge	Oldbury	10	30	7	1
	Corwen	Ruabon	16	6	7	1
Lancashire & Yorkshire Railway	Southport	Altcar	9	11	9	1
	Southport	Barton	6	44	8	
	Burnley	Nelson	3	29	2	1
	Burnley	Colne	5	29	4	
	Ormskirk	Aintree	7	26	4	2
	Ormskirk	Rainford	6	5	3	
	Bury	Holcombe Brook	3	20	7	1
	Bury	Bacup	12	13	8	
	Bury	Holcombe Brook	3	20	7	1
	Bury	Clifton Junction	5	71	3	
	Sowerby Bridge	Rishworth	3	69	3	1
	Halifax	Stainland	3	52	3	1
London & North Western Railway	Bletchley	Bedford	16	0	12	1
	Oxford	Bicester	11	70	7	1
	Loughborough	Shackerstone	16	0	8	1
	Bangor	Bethesda	4	70	2	1
	Walsall	Rugeley T. V.	15	20	8	1
	Walsall	Lichfield City	10	40	5	1
	Rhyl	Dyserth	7	0	5	1

NAME OF RAILWAY		Points between which cars are run.		Distance. M.	C.	Intermediate stops.	Number of cars daily employed.
Midland Railway	Classes 2 and 3	Bedford	Hitchin	16	20	4	1
	Classes 2 and 3	Bedford	Northampton	21	40	3	1
	Class 2	St. Albans	Luton	10	20	2	2
	Classes 2 and 3	Harpenden	Heath Park	8	0	4	
	Class 1	Trent	Stanton Gate	4	0	2	1
		Trent	Sandiacre	2	60	1	
	Class 2	Derby	Melbourne	7	0	2	1
		Derby	Ripley	10	0	5	
		Derby	Wirksworth	13	60	5	
	Class 3	Wakefield	Sandal and Walton	2	60	...	1
		Wakefield	Cudworth	9	0	2	
		Sheffield	Doncaster	18	60	10	1
		Sheffield	Barnsley	16	0	7	
North Staffordshire Railway		Leycett	Stone	14	0	14	...
North Eastern Railway		Selby	Cawood	5	20	1	1
		Selby	York	13	60	3	1
Rhymney Railway		Rhymney	Ystrad Mynach	10	0	8	1
		Merthyr	Ystrad Mynach	11	0	6	
		Caerphilly	Machen	4	0	3	1
		Caerphilly	Senghenydd	4	40	3	
Taff Vale Railway		Aberdare (Mill Street)	Pontypridd	11	43	8	2
		Treherbert	Pontypridd	10	54	11	2
		Merdy	Pontypridd	9	49	8	
		Nelson	Pontypridd	5	70	5	1
		Old Ynysybwl	Pontypridd	4	41	2	2
		Aberthaw	Pontypridd	20	21	15	2 1 (short train)
		Pontypridd	Cardiff	11	67	7	
		Cardiff	Cadoxton	9	38	11	3 1 (short train)
		Cardiff	Cardiff Docks	1	9	...	
Dublin & South Eastern Railway		Westland Row	Kingstown	6	0	6	2
Great Northern Railway (Ireland)		Dundalk	Portadown	33	40	7	...
		Newry	Goraghwood	3	60	...	...
		Dublin	Howth	8	20	4	...
		Belfast	Lisburn	7	40	7	...
Madras & Southern Mahratta Railway		Ongole	Gudur	96	0	14	2
		Bangalore Cantonment	Marikuppam	56	0	11	1

SECTIONAL DISCUSSION

(2nd and 3rd SECTIONS MEETING JOINTLY)

Meeting held on 6 July, 1910 (morning).

MR. GERSTNER IN THE CHAIR.

The President. (In French.) — Gentlemen, the 2nd and 3rd section are meeting jointly today in order to discuss question XII, but as this question is also of interest to the members of the 5th section, who deal with light railways, I think it would be advisable to ask them to join us. If there is no opposition, this shall be done.

2nd, 3rd and 5th SECTIONS MEETING JOINTLY.

Mr. Gerstner. (In French.) — Gentlemen, I propose to the three joint sections to appoint Mr. Dietler, president of the 3rd section, to be our president. (*Approval.*)

— Mr. DIETLER takes the chair.

The President. (In French.) — Gentlemen and dear colleagues, I thank you for the confidence you kindly show in me and I venture to hope for your kind cooperation.

I propose to you that we should hear the reporters in the order given in the list of questions. As the first reporter, Mr. Riches, is not present, I call upon Mr. C. Peter Clark to give a summary of his report.

Mr. C. Peter Clark, *reporter for America.* — There are Gentlemen, conclusions, presented at the bottom of the report I wrote on question XII, and which has been distributed to the members of the Congress :

The fact that interest in this subject continues on every side and that different roads and Companies continue to produce new types of apparatus upon the same general line is a very encouraging sign.

The question of expense, first cost of repairs and depreciation cannot be satisfactorily determined by the performance of isolated cars under different weather and topographical conditions where the prices for the same kind of fuel and service vary greatly.

The marked tendency of the past three or

*

four years based upon the numbers built, is unquestionably in favour of the car operated by gasoline and without the additional electrical complications, but this, by no means, proves that the experiments of the next three or four years may not introduce new features giving even more satisfactory apparatus at less cost and susceptible of even cheaper operation.

The amount at stake is so large that the continued study of the subject is clearly warranted, and circumstances appear to justify the belief that apparatus of this kind alone will enable steam railroads to protect passenger business which otherwise will be lost to them.

Since the publication of the report, with the conclusions which I have just read, the situation in America has changed but little, except that the building and orders for motor cars have increased considerably, which shows that this question is receiving much attention.

The report states the fact that the passenger trains of the United States carry an average of fifty-four passengers; by deducting heavy trunk line trains and suburban trains near large cities, it is evident that a large portion of the trains in the United States are handling a traffic which could be very well taken care of by a single motor car of reasonable dimensions.

The various types of motor cars are classed as follows :

A. — *Motor cars driven by steam using coal as fuel.* — This type is but the development of similar cars built many years ago in America, which never met with general favour, on account of their cost, and because the coal and machinery are so heavy and bulky.

Motor cars driven by steam using oil as fuel. — The firing in this case is simplified, but the employees refused to accept the reduction of the number of men on locomotives made possible by the substitution of oil for coal, and it is quite probable that they will take the same position towards motor cars.

Up to this time there have been but experimental cars of this type.

B. — *Motor cars driven by internal combustion engines with a mechanical transmission of power.* — In June 1909 there were but forty-six cars of this type, built according to the Mac Keen patent; but in May 1910, seventy-five of them were in service, which shows a general disposition in favor of this type of car.

C. — *Motor cars utilizing internal combustion engines operating dynamos in connection with an electric drive with or without storage batteries.* — The report refers to two types of this kind : the first being an experimental car built by the General Electric Company, which had been in service but a short time at the writing of the report.

Since then, this car has given such good results that 13 of this type have been ordered by six different companies, and negotiations for more are being conducted.

It will be about two months before these cars are ready for service, but the orders denote the best judgment of those who have studied the construction and the service of the experimental car.

We hear nothing of new orders for the type of car quite similar, described in the report under the heading of " Strang gas-electric car ".

In examining the present condition of

the development of motor cars in America, we note the preference shown for the gasoline car; it is still an unsettled question, however, whether the benefit of the electric transmission is sufficient to offset the additional weight represented by the dynamos and motors, which necessarily increases the expense of building and maintenance.

This question cannot be definitely solved by results obtained from the service of one or two experimental cars for a few months; but will require a longer and more general service for definite results.

In conclusion, I have no modification to propose to the summary presented in the report as prepared and printed in 1909.

Mr. Greppi, *reporter for all countries except Great Britain and America.* (In French.) — Gentlemen, question XII relates to motor vehicles, more especially from the point of view of use and cost. The report, of which I will give you a summary, deals with all countries except the English-speaking ones.

Of forty-three administrations who sent answers to the list of questions, twenty-six replied that they had no motor cars or equivalent small locomotives in use; that they never had any and did not intend to have any built.

The Baden State Railway has made trials with two motor cars, no longer used. Three other administrations limit themselves to the statement that they operate several services of a local character with small tank locomotives of old types. This only leaves thirteen answers from administrations who are at present trying motor cars or using them in the regular service.

In my report I have also described the motor luggage vans which more or less resemble motor cars. The same applies to trials and investigations made with a view to utilizing small locomotives instead of motor cars. On the other hand, I have left out of consideration the electric cars taking current from outside.

The thirteen administrations which answered the list of questions own 195 motor-cars which, classified according to kind of motor, give the following groups:

185 steam motors, 85 being motor luggage vans;

7 motor cars with internal-combustion motor;

3 electric accumulator motor cars.

These figures do not include the luggage-van locomotives of the French State Railway and the small locomotives which are being tried by the Baden State Railway and the Austrian State Railway; all of these have steam engines.

It has also to be remarked that there are motor cars of recent type on trial or in use on lines belonging to some administrations which did not answer the list of questions. Such are the Stoltz steam cars, the petrol cars and the accumulator cars in Prussia, and the benzo-electric cars of the Weitzer type in Hungary. Another new type of benzo-electric car will be tried in Belgium on local lines.

It may however be said that the development of motor-car services, which seemed in full activity from 1900 to 1907, has rather stopped during later years.

As regards kind of motor, steam cars are still the most numerous, in spite of the nearly inevitable disadvantages they have. In more recent investigations, there seems to be a tendency in favour of petrol

motors, which are probably more suitable for the services for which motor cars can be used. But it seems that as yet no satisfactory type for current use has been evolved.

As regards the dimensions of the cars, the most recent designs show a tendency to prefer cars with three and with four axles, rather than cars with two axles, which have a very small capacity.

Nearly always in the four-axle cars, and often in the three-axle cars, we find a separate motor truck, with two axles supporting the whole motor; this motor truck can be removed for purposes of repair from the carriage body and afterwards replaced.

The smallest units are represented by the Ganz type, with de Dion steam motors of 30 to 35 horse-power car with two axles, weighing 13 tons empty and 16 tons when loaded, and by the Daimler petrol type, having nearly the same weight. The heaviest are the four-axle cars of the Italian State Railway and the Bavarian State Railway, with motors of about 200 horse-power, and weighing up to 43 tons empty and 52 tons when loaded.

The corresponding maximum axle-loads vary between 11 tons and about 15 to 16 tons respectively.

A tendency towards simplification, either in design or in working, is shown by the reduction in the number of classes. In some cases there is only one single class.

A rather long platform is always provided, affording standing room for a certain number of passengers.

In recent types the continuous brake is nearly generally adopted and steam heating is always used in the case of steam cars, and hot-water (the cooling water from the motors) heating in the case of cars with internal-combustion motor. Coal stoves are still to be found in the accumulator cars, of which however there are but few.

As regards draft gear and buffing gear, there are only two cases where special provision is made in the case of cars which are intended always to travel by themselves, or only to haul a special trailer: the petrol car of the Swiss Federal Railway and the benzo-electric cars, on the Weitzer system, which it appears are used on the Arad-Csanad Railway.

Coming now to the mechanical part of the subject, we find the following types of boilers used in the steam cars: ordinary boilers with smoke tubes, of the locomotive type, are used on the old Belpaire cars of the Belgian State Railway, on some of the four-axle cars of the Bavarian State Railway and on the four-axle cars of the Italian State Railway. The boiler is placed crosswise in one of the two types of the Italian State Railway, but this arrangement has been given up and is altered when repairs are being carried out, the objection being the displacement of the water-level when running round curves. In the other case the boiler is placed longitudinally and the fire-door is on one side of the fire-box.

Vertical boilers with smoke tubes are used on the motor luggage vans of the Italian State Railway and on the motor cars of the Wurtemberg State Railway. In the latter, the barrel is enlarged at the upper part, like the well-known vertical boilers of the motor cars of the Great Western Railway, and the fire-box is of Fox corrugated plate.

The Italian State Railway has also, as a

trial, fitted some of its luggage motor vans with such a barrel enlarged at its upper part; this increases the reserve of water and of steam, reduces the variations in the water-level and increases the life of the tubes. A certain number of these vans has also been equipped, as an experiment, with the Komarek boiler.

I am now in a position to be able to say that of the different types of boiler used on the luggage vans of the Italian State Railway, the Komarek boiler gives the best efficiency; but the vertical boiler with its barrel enlarged at its upper part is preferred, as this has proved superior from the point of view of maintenance.

The water-tube boilers which are used on motor cars include : the Komarek type, which is in use in Austria; the de Dion, Field, Turgan, and Serpollet types of which rare instances are found in Austria, in Belgium, in Bavaria, in Wurtemberg and in France; and the well-known Purrey system, which is an improved derivative of the Serpollet system, and is used in Italy and above all in France.

There is also the Stoltz boiler used on the Prussian State Railway, but about this I have not received any direct information.

All these types are more or less well-known. Nothing new has been invented during the last few years.

Steam superheating, which is inherent in the very types of the Serpollet and Purrey boilers, is also used to a limited extent in the Kittel and Komarek boilers. The Bavarian State Railway uses the Schmidt superheater.

The working pressure varies between 12 and 16 kilograms per square centimetre (between 170 and 228 lb. per square inch), except in the case of the Serpollet and Purrey types where the pressures are very high, and in that of the de Dion boilers of the Ganz cars, where it is 18 kilograms per square centimetre (256 lb. per square inch).

The grate areas vary between 0·33 and 1·08 square metres (between 3·55 and 11·62 square feet), and the heating surfaces between 8·5 and 60 square metres (between 91·50 and 645 square feet). The corresponding power limits are about 35 and 200 horse-power.

Coke is used as fuel for the Purrey boilers and sometimes also for the de Dion boilers; in all other cases coal is used, with the sole exception of the petroleum Serpollet car on the Paris-Lyons-Mediterranean Railway, which is however no longer in use.

There is no application of the heavy-oil firing system, which is however applied on some of the small locomotives of the Austrian State Railway and which it seems can be recommended, as only one man is required on the locomotive. But difficulties would be encountered in adapting this system suitably and practically to small fire-boxes.

As regards the engine, single expansion generally is used except in the case of cars of the Ganz and Purrey types.

I have nothing fresh to say about the few accumulator cars, none of which are new except those of the Prussian State Railway, about which I have received no information.

The sole type of petrol motor used on the motor cars on this Continent is the Daimler. As yet there is in Europe no application of the gasoline motors of recent type which are in use in America.

It occurs to me, however, that certain designers are considering the use of motors in which heavy oils are burnt, such heavier oils being cheaper than petrol or gasoline.

An important problem which arises in the case of motor cars, and which is connected with the system of working adopted, is that of the controlling gear, with a view to running in both directions.

The ideal solution of perfect symmetry is only attained in the petrol cars and in the accumulator cars.

In the case of a certain number of steam cars, the problem of running in both directions has been left out of the question; as hort wheelbase has been adopted so as to make it possible to turn the cars on the ordinary turn-tables at the stations, as in the case of the motor luggage vans of the Italian State Railway, or on the locomotive turn-tables, as in the case of the Ganz and the Purrey cars.

It is, however, interesting to note the method adopted in the case of the three-axle Purrey cars, with motor truck, on the Orleans Railway; these are turned by means of an auxiliary traverser which receives the third axle of the car and runs on a circular track concentric with the turn-table which has a diameter of 4·400 metres (14 ft. 5 $^1/_4$ in.).

The solution frequently adopted in England, which consists in utilizing a little train formed with two bogie carriages and a locomotive or motor car in the middle, having a rather larger loading gauge, has received no applications on the Continent.

In all the other cases, the cars have a fully-equipped cab at the end where the engine is, and at the other end, an auxiliary cab or a simple post of control occupied, when running backwards, by an employee. The appliances the latter generally has available are the valve operating the brakes, a compressed-air or steam whistle and a lever for closing the régulator.

An exception is formed by the small Serpollet and Kittel cars on the Wurtemberg State Railway, on which there is only a whistle and an extra brake valve at the post of control; the employee there must not intervene except in the case of danger. The cars of the Kittel type have cabs with a larger cross-section so as to enable the driver to see the track when running backwards.

The problem of replacing motor cars by small locomotives of special design has been closely investigated by the Bavarian State Railway and the Austrian State Railway. The latter has in use two small locomotives, with two axles, with fire-boxes heated by petroleum residues, the burners being of the Holden type. The Bavarian State Railway uses for its local services sixty small locomotives designed by the firms Maffei and Krauss. I should very much like to obtain information, from the Bavarian delegates, about the working results of these locomotives.

The French State Railway still uses its luggage-van locomotives of an already old type, capable of hauling up to sixteen axles.

Passing now to the question of the organization of motor-car services, I find that the use of motor cars alone is rather rare, evidently because such a train unit is too small to meet the least variation in the number of the passengers.

The number of trailers is usually two or

three, and attains four and five in the case of motor cars with powerful boilers.

The typical light train of the Italian State Railway consists of a motor luggage van hauling two four-axle carriages of large capacity designed for the local services, or else of a motor-car hauling a trailer which also has four axles.

Intercommunication between the motor car and the trailers by means of gangways for the employees is not generally provided.

No administrations allow automotor cars or small locomotives to push other cars; this practice is adopted by some of the English companies.

The use of one single man as driver and of one conductor or guard is a rule without exception in the case of petrol cars and of accumulator cars. The same system is generally adopted on the lines which use steam cars of the Serpollet, Purrey and Kittel types, with or without trailers.

In the other cases, this system is not generally applied.

The cars of the Ganz and the Komarek types and the Bavarian State Railway four-axle cars are worked by two or by three employees, according to the condition of the service and the compositon of the train.

In Belgium and in Italy, the steam cars with boilers of the locomotive type or vertical boilers are generally looked after by two engine men, plus a conductor.

In principle, the possibility of having a single traction employee, which is one of the most important factors in reducing the working expenses by the use of automotor cars, depends on several conditions which it is not always possible to realize fully when using steam engines.

As regards design, in the first place it is necessary that the driver should have a good view of the track and the signals, and everything possible must be done to reduce the attention the boiler requires to a minimum, either by the use of a semi-automatic stoking appliance, or by that of liquid fuel.

Experiments of this kind have been made on the Bavarian and Austrian motor cars. It would be desirable that the delegates of those countries should inform us of the results obtained.

Besides the solutions already mentioned, the reduction of the traction staff to one driver can also be realized when the load is limited, the gradient is easy, the stops not far apart and the whole run a short one, for it is then possible to do the firing work during the stops, and the variations in the water-level while running are reduced. Another condition also required is that the line should not have too many trains running on it, or have too many signals, junctions, etc.

Finally, assuming that the traction staff can be reduced to one man, it is necessary that one of the guards or the conductor should be able to take his place in case of necessity. In order that the whole number of men on the train may be reduced to two or three, according as one or two are required for the engine, there must be intercommunication between the motor car and the train, or else the continuous brake must be available and the number of trailers must not exceed two or three.

It must also be remarked that difficulties opposing a reduction in the staff are sometimes caused by the employees themselves.

When motor cars are available having

the motor at one end and at the other an auxiliary post of control, it is more usually the driver who takes his place on the latter while running backwards. On some lines, however, the driver remains by the motor and the fireman takes the other post.

The mileage of motor cars per day of service is, according to the information received often less than that of the locomotives. This is explained by the short length of the runs or by the very character of the auxiliary service, intercalated between the chief trains, for which the motor cars are used.

The mean annual distance covered varies, according to the figures received, between 8,000 and 33,000 kilometres (between 4,970 and 20,500 miles). The coefficient of utilization, that is the ratio between the number of days of service per year and the number of days in a year, or else the ratio between the actual mileage of each unit and the theoretical mileage represented by 365 times the daily mileage, appears to be appreciably less in the case of motor cars than in that of locomotives.

According to the answers I have received, this coefficient varies between 29 and 65 per cent, whereas it varies with locomotives, in my opinion, between 70 and 75 per cent.

The use of small train units gives rise to certain problems in connection with the operation of the traffic, problems which generally do not arise when locomotives are used.

Certain administrations consider the motor-car trains to be trains with a limited number of places, and the public is informed of this. But more frequently locomotives are substituted for the motor cars, or extra trains are arranged if there is an exceptional rush of passengers. The former of these two methods seems to be preferred, as regards the requirements of the public.

Difficulties of this kind have arisen more especially when motor cars of low power were used.

Motor cars are more frequently used in order to form local trains intercalated between those hauled by locomotives. There are, however, in France, in Italy, in Belgium and in Bavaria, several instances of such motor cars being used for the whole of the passenger service on secondary lines.

In that case, goods trains are run. But this system of operation is not convenient if there is much cattle and quick-freight traffic, requiring a number of trucks beyond the power of the motor car, but not justifying the expense of trains hauled by locomotives expressly run for the purpose at certain hours.

From the point of view of facilities in the use of motor cars, the distance which can be run without taking in supplies is important.

From this point of view, cars with an internal-combustion motor, also to be recommended from the point of view of the better utilization of the room available and from that of cleanliness, are the most suitable.

The distance the Daimler petrol cars can run without taking in stores is about 280 kilometres (174 miles).

As regards the regularity and the flexibility of the service, the administrations which have tried or which use motor cars of small size and of low power are those who make most complaints. Such complaints

are made by the Saxon State Railway, the Swiss Federal Railway, the Paris-Lyons-Mediterranean Railway, about the Serpollet cars; by the Italian State Railway about the Purrey cars; and by the Wurtemberg State railways about the Daimler and the Serpollet cars.

The want of flexibility is also admitted by railways which, like the Bavarian State Railway and the French State Railway, use cars of medium power.

It is remarked that although the flexibility required in the service is definitely limited by the limited dimensions of the boilers, it is always possible to ensure sufficiently regular running by having time-tables allowing a sufficient margin; this comes to the same thing as reducing the inclusive speed.

The administration of the Wurtemberg State Railway reports that its most recent cars with Kittel boilers give every satisfaction when used for its local services, and that the irregularities in running are neither greater nor more frequent than with the locomotives. The Paris-Lyons-Mediterranean Railway expresses the same opinion about its Purrey cars.

As regards difficulty of maintenance, most of the administrations which have used motors or boilers of special types state that maintenance is more costly than in the case of locomotives, owing to the special character and the complication of the mechanism.

However, the Purrey cars, which gave some trouble on the French State Railway, work well on the Paris-Lyons-Mediterranean Railway, subject to careful washing out.

The administration of the Wurtemberg State Railway declares that the upkeep of boilers of the Kittel type is not more costly than that of locomotive boilers.

The Italian State Railway has had trouble with vertical boilers, in consequence of leaks at the tubes and of the costly maintenance due to excessive utilization at the start. The boilers when modified and used for less heavy work give satisfaction.

The upkeep of horizontal boilers of the locomotive type, as compared with that of locomotive boilers, has given rise to no special remarks.

The use of spare trucks for motor cars having a motor truck separate from the main frame is considered advisable in order to reduce the immobilization of the car.

It would be interesting to have figures about the immobilization of motor cars due to their replacement by locomotives, owing to unusually busy passenger traffic; but the information obtained about this point is defective.

The substitution of locomotives on Sundays and holidays is the regular practice on some German lines; in Switzerland it is on market days.

Such substitution on fair days and market days is rather common on the Paris-Lyons-Mediterranean Railway. On the Orleans Railway, it is estimated that this substitution takes place in the case of from 5 to 20 per cent of the trains. On the Italian State Railway, this inconvenience formerly turned up rather frequently, but it has been reduced considerably by organizing the services, so that the motor luggage vans and the motor cars are only used in the cases they suit best.

One measure which is extensively and usefully adopted in order to facilitate motor-car services, is the reduction of the

number of classes to two and even to one. The administration of the Wurtemberg State Railway has adopted the single class for its services generally and finds this very satisfactory from the point of view of the simplification of the service.

The data received about the consumption of fuel vary according to the different conditions of the service. In the case of motor cars on which coal is used, the consumption varies between about 3 and 9 kilograms per kilometre (between 10·6 and 32 lb. per mile).

The information received about the cost is very limited, as was to be expected, and the data can only be compared with difficulty.

I find costs of operation varying between 16 and 62 centimes per kilometre (between 2·472*d*. and 9·579*d*. per mile).

The Austrian State Railway gives the following figures for its system :

Daimler cars	0·316	franc per kilometre	(4·882*d*. per mile).
Serpollet cars	0·309	— —	(4·774*d*. —).
Komarek cars	0·331	— —	(5·114*d*. —).
Locomotives series 86 and 185. .	0·362	— —	(5·593*d*. —).

On the Austrian State Railway, the Komarek cars cost 38,000 francs (£1,520) and 54,000 francs (£2,160), according to series, while the small locomotives of the two series cost 23,000 and 29,500 francs (£920 and £1,180).

We see that the difference between the two prices represents the cost price of an ordinary carriage with a capacity similar to that of the autocar.

On the other hand, as we have already seen, the annual mileage of the locomotives can more easily attain high figures.

My report results in the following conclusions:

1° Automotor cars can be used in certain cases for economic services, in order to facilitate local communication at a moderate outlay, provided that the traffic conditions lend themselves to the organization of frequent trains, carrying a regular traffic or at least one which only varies rarely and but little, that the line is an easy one and that the goods traffic can be carried conveniently and completely on separate trains;

2° The power of the motors of the automotor cars should present a certain margin beyond the ordinary work, so that it is possible to cope with variations of the traffic within certain ascertained limits;

3° It would be desirable to make it possible to utilize the car independently of the motor by having either separate motor trucks, or some other device making it possible to remove and replace the mechanical part easily;

4° From the point of view of economy of staff, that is to say, having only one traction agent, accumulator or petrol cars seem the most suitable. The types used by the administrations which have given me information represent units of too low a power. It would be desirable that investigations should be made in order to increase this power suitably and to ensure easy and inexpensive maintenance;

5° As regards steam cars, it would be desirable to reduce to a minimum the care required for the boiler and in particular to improve the semi-automatic feeding of the grate or to improve the methods of using liquid fuel;

6° It would be desirable to recommend the investigation of small locomotives able to replace automotor cars, with the advantage of greater independence. The luggage-van locomotives, or the motor luggage-vans, represent an intermediate solution, which it seems can be suitably applied in certain cases.

The President. (In German.) — Gentlemen, I think I am acting as your mouthpiece in thanking the reporters whom we have just heard, for their very clear and complete summaries.

If nobody objects, I think that we might take as basis, for our discussion, the conclusions given in Mr. Greppi's report, which he has just read out. The other reporter, Mr. Clark, agrees with me as to this procedure.

Mr. Greppi. (In French.) — I would request the President to ask the representatives of railways who have a considerable number of motor cars in use and who have not sent answers to the list of questions, whether they have not got any useful information which they might supply to us. I am thinking more especially of the Hungarian railways, about which I could not say anything in my report as I received no answer from them; and they use a considerable number of cars of the Ganz and the Weitzer types. I am also thinking of the Prussian State Railway, which I have incidentally mentioned in my report, and finally, of the Bavarian State Railway, which has at present in use a considerable number of small locomotives, the designs for which were worked out when that railway already had a motor-car service.

Mr. Steinbiss, Prussian-Hessian State Railway. (In German.) — The Prussian-Hessian State Railway was unable to supply any information for Mr. Greppi's report because the list of questions was either not sent to them or else went astray.

Up till 1907 only 5 steam cars had been constructed, namely 1 Thomas car and 4 Ganz cars, then later on came 2 Stoltz cars, as an experiment. Steam cars have been given up since.

In 1907 we put in use 5 accumulator cars, with three axles, 12·2 metres (40 feet) in length; their tare was 33·5 tons (33 English tons) and they took 60 passengers. The good results obtained led to the construction of 57 double cars with accumulators, 22·11 metres (72 ft. 6 1/2 in.) in length, with series motors and four axles, taking 100 passengers normally and 130 as a maximum; they weighed 54·5 tons (53·6 English tons) when empty and 63 tons (62 English tons) when fully loaded. The two cars are coupled by means of short couplings, the batteries and the cabs are at each end; they have two motors of 80 to 90 horse-power each. The maximum speed is 60 kilometres (37·3 miles) per hour and the length of run is 100 kilometres (62 miles) at a speed of 50 kilometres (31 miles) per hour on the flat and on easy gradients.

These cars, put in use in 1908, are also used on lines with short up-gradients of 12·5 per mil, and exceptionnally of 16 2/3 per mil.

At the same time a double car with 4 shunt motors of 50 horse-power was built, able to run 100 kilometres (62 miles) and to carry 95 passengers.

In consequence of the good results obtained, it was decided in 1909 to build 33 more accumulator cars with series motors and 5 cars with shunt motors (all twin, but with six axles), to be ready in 1910. One of these cars with series motors is at present at the Brussels exhibition. It is intended to build 35 new motor cars of this kind in 1911.

Besides these accumulator cars, a benzol car with electric drive was also built and

put in service in 1909, as an experiment. This car is on two Krauss bogies, and has a length of 16·96 metres (55 ft. 7·3/4 in.); it takes 81 passengers and weighs 37·5 tons (36·9 English tons) when empty and 43·1 tons (42·4 English tons) when loaded. The benzol motor develops 90 horse-power when running at 700 revolutions per minute. The dynamo is designed for a continuous output of 38 kilowatts or for one of 80 kilowatts for one hour, and the two driving motors give 50 horse-power for one hour each. The exciter absorbs 4 kilowatts.

Eight other benzol motor cars, of a modified type, are being built in 1910 and it is proposed to built ten others in 1911.

In 1909 no definite data were yet available as to working results. In 1910 it was possible to see that the results obtained with the accumulator cars in 1909 were very satisfactory. The annual mileages of the double car appreciably exceeded 50,000 kilometres (31,000 miles) and in some cases attained 70,000 kilometres (43,500 miles). Allowing for spares, the different railway managements obtained an annual average of 25,000 to 50,000 kilometres (of 15,500 to 31,000 miles) per double car.

From the technical point of view the new cars have perfectly satisfied the required conditions and are much in favour with the public on account of the smoothness of their running and the elimination of the discomforts caused by smoke. From the economic point of view they have given appreciable advantages by opening up and stimulating the traffic on branch lines, by the quicker succession of passenger trains on the main lines and by making connections with the fast trains.

The working expenses, including interest and amortization of the cars and the power stations, vary, with the cost of the current, the nature of the line and the speed of the trains, between 45 and 65 pfennige per car-kilometre (between 7*d.* and 10*d.* per car-mile); it is, however, hoped, by means of suitable improvements, to reduce this figure to a mean of 50 pfennige per car-kilometre (7·72*d.* per car-mile).

Each car has two employees on it, namely a driver and a conductor.

For some time now, in order to meet sudden rushes of traffic, trailers have been added to the accumulator cars; these are carriages with two and three axles, holding 50 passengers, and weighing 11·5 and 14·5 tons (11·3 and 14·3 English tons) when empty and 15 and 18 tons (14·8 and 17·7 English tons) when loaded, so that the motor-car trains attain a weight of 81 tons (79·7 English tons) and can carry 150 to 180 passengers. These trains run up gradients of 7 per mil at speeds of 25 to 28 kilometres (15·5 to 17·4 miles) per hour and moreover run on the flat at the normal speed of 50 kilometres (31 miles) per hour. The distance the car can run is reduced, in this case, to about 70 kilometres (43·5 miles). A third employee, acting as guard, is on the trailer.

The President. (In German.) — I would remind you that Mr. Greppi has asked whether the delegates of the Hungarian State Railway and the Bavarian State Railway had no supplementary information for us.

Mr. Greppi. (In French.) — I named the administration of the Bavarian State Railway, which has however already answered the list of questions, because I wished to

know whether it could not give us supplementary information about its small locomotives. This administration in fact told us that the small locomotives had only been in use for a short time and that at that time there were forty in use, and twenty under construction. I suppose that the small locomotives under construction are accordingly now in use; on the other hand, those which were already in use have now done longer work and I therefore think that this administration could give us interesting supplementary information.

Mr. Papp, Hungarian State Railway. (In German.) — The Hungarian State Railway has motor cars of different kinds in use since 1904. There are 30 two-axle cars, with boiler and de Dion motor; then 6 cars with two and with three axles, either of the same type or petrol-electric cars, and these are used on narrow-gauge lines; and finally, 7 three-axle cars of the Stoltz type, for standard-gauge lines; 6 others have just been delivered and are not yet in use. In addition we have 7 four-axle standard-gauge cars with a more powerful de Dion motor; 4 petrol-electric cars from the firm Weitzer of Arad, also standard-gauge, and 1 Komarek car which is at present being equipped with a Kittel boiler. Then we have 2 small Bavarian locomotives, on the Maffei system, and 25 locomotives with Brotan boiler and with the superheater of the type used on the Hungarian State Railway. With 22 compound two-axle locomotives of an older type, this makes altogether 110 vehicles for motor-car and other similar services. The two-axle motor cars take 40 and the four-axle cars 96 passengers. The average weight of the two-axle cars, passengers included, is 20 tons, and that of the four-axle cars is 37 tons. The small locomotives weigh, in running order, about 20 tons. The motor cars are intended to make annual mileages of 30,000 to 35,000 train-kilometres (18,600 to 21,750 train-miles); actually they make sometimes up to 40,000 train-kilometres (24,850 train-miles). The cost of traction per kilometre, including the train staff, is 26 pfennige (5·02*d.* per mile) with the steam cars, 36 pfennige (6·95*d.*) with the Stoltz cars and 32 pfennige (6·18*d.*) with the petrol-electric car. The cost of upkeep is not included.

I very much regret that Mr. Greppi received no information from us. Either the list of questions did not reach us, or the answer went astray.

The President. (In German.) — Do the working expenses given by Mr. Papp include interest on capital outlay.

Mr. Papp. (In German.) — No.

Mr. Koechlin, French Northern Railway. (In French.) — Mr. President, I note that in the list of French railways using motor cars the French Northern railway is not mentioned. This railway has, however, at present some ten of these cars in use, and it is even exhibiting one at Brussels. If I address the meeting, it is because I wish to tell those of our colleagues who will visit that exhibition that we are very ready to supply them with any information about these cars, which they may desire. The car exhibited is in the French section next to the rolling stock of the French Northern Railway.

The motor car in question is interesting

because it consists of three parts and is reversible, or rather it can run in both directions. The engine is placed between two carriages, one being pushed and the other pulled, so that at the terminus the driver has only to pass from the post of control in one corner of the cab to the post of control in the opposite corner, in order to drive his engine. Each of the parts of the car has a body slightly out of line, that is to say, the body is rather smaller than the loading gauge and is placed a little towards one side, so that the driver has a clear outlook from each of the positions he has to take. Hence, it is unnecessary to turn the car, and this is a very important point. Those of our colleagues who go to Paris can see these cars running between Paris and St. Denis stations; they are every day used for a shuttle service on the Paris Ceinture Railway.

If my memory is correct, these cars weigh about 45 tons with all their gear. The central motor weighs 20 tons; it only includes a small boiler of the ordinary locomotive type. The engine is of the ordinary type with driving axles and the cabin contains two posts of control.

As I said at the start, the railway posesses some ten of these locomotives which are used on different parts of its system.

Mr. Reverdin, *secretary-reporter*. (In German.) — Mr. Vas, inspector-general of the Arad-Csanad Railway, in Hungary, whose general manager, Mr. de Fabry, has not yet arrived in Berne, has requested me to give you some information about the use made of motor cars by that railway.

The lines of that railway are altogether over 460 kilometres (285 miles) in length; of these 70 kilometres (43·5 miles) are narrow-gauge and the rest standard-gauge lines. This railway has since 1902 been using vehicles with motors of different systems, and also special locomotives. It has 12 special cars in use on narrow-gauge lines; there are 8 Ganz steam cars, 1 benzene car, 2 steam locomotives and 1 benzene locomotive with electric motors. On standard-gauge lines it has 41 motor cars in use; there are 4 Ganz steam cars, 1 Daimler benzene car and 36 benzene cars with electric motors, most of them equipped by the Westinghouse Company; 22 of these cars are of 40 horse-power, 14 are of 70 horse-power. Most of these cars have two axles and weigh 13 to 16 tons when empty. Their running speed is from 30 to 60 kilometres (from 18·6 to 37·3 miles) per hour; as a rule they haul two or three trailers. The most powerful cars, those of 70 horse-power, are specially used for an express service. They haul two to three trailers, the gradients not exceeding 6 per mil. They take 25 to 40 passengers and run 200 to 300 kilometres (124 to 186 miles) without taking in supplies. As regards the number of trains hauled in the different ways, there are 12,000 trains with locomotives and 18,000 motor-car trains; accordingly these represent 60 per cent of the total. There are about 40 motor-car trains per day, on the whole system. The annual mileage of a locomotive as a rule attains 28,000 to 30,000 kilometres (17,400 to 18,600 miles), that of a motor car 35,000 to 40,000 kilometres (21,750 to 24,850 miles). The cars are lifted for inspection every three or even only every six months. The working expenses per kilometre amount in the case of the benzene cars with electric motors to about 35 centimes per kilo-

metre (5·40*d*. per mile). and in that of steam cars to about 82 centimes per kilometre (12·67*d*. per mile). The company states that it is very well satisfied with the last types of its benzene electric cars, which it has had in use since 1905-1906. The first cars of this kind had to be modified slightly in order to give them a little more power. The material increase in the receipts, and especially in the net profits, is attributed by the company to the use of this system since 1906; in fact the net profit in 1903 was 1,600,000 kronen (£66,560) and increased in 1909 to over 2,400,000 kronen (£99,840). It should be mentioned that the receipts which amounted in 1909 to 5,900,000 kronen (£245,440) include 1,900,000 kronen (£79,040) for passenger traffic and 4 million kronen (£166,400) for goods traffic. The goods service is hence of considerable importance fromthe point of view of receipts.

It should be added that the goods service is wholly operated by means of steam locomotives, which also haul every day certain trains known as military trains.

Mr. Lippetz, Russian State Railway. (In German.) — In Europe petrol cars are only used with electric drive; in America there are cars in which the motors drive the axles direct. Consequently, the electric motor is a decided improvement. It would hence be interesting to know how the difficulties of a direct drive have been overcome, as henceforth many countries will think of adopting motor cars and it would be useful to elucidate, more or less completely, the question whether direct drive or the electric drive is to be preferred.

The difficulty of a direct drive of the axles by the motor, as that on steam locomotives, arises from the fact that the internal-combustion motor has less flexibility than the steam engine from the point of view of change of speed. The motor will not work at less than a given number of revolutions per minute; below this limit ignition fails. In order to obtain smooth starting, a special clutch is required. The description given by Mr. Clark does not make it quite clear how this problem is solved in the MacKeen car. He says in fact, if I have understood him correctly, that the driving axle is acted on in two ways : 1° by a chain gear and a friction clutch; 2° a spur gearing (see fig. 6 of the report, which shows a truck with spur wheels); after disengaging the one the other is brought into use.

I will therefore ask the reporter for America several questions :

1° What is the number of revolutions of the motor before the friction clutch is applied for starting?

2° What is the number of revolutions of the motor and of the driving axle, and, consequently, the speed of the car, after the clutch is in use?

3° What is that speed after the release of the clutch?

4° How is starting effected? With or without jerks?

5° Within what limits can the number of revolutions of the motor be varied?

The President. (In German.) — The questions asked by Mr. Lippetz refer to technical details. But would it not be better, in order to save time, that the reporters should give answers to those interested, direct? I propose that we

should keep to the general discussion. (*Approval.*)

Are there any other delegates who wish to give any information?

Mr. Kabodi, Hungarian State Railway. (In German.) — You have been told that there are altogether over 60 motor cars on the Hungarian State Railway. I would supplement the summary which has been given to you of the state of the motor-car question in that country. We have in Hungary a whole narrow-gauge railway system whose working is based above all on the use of motor cars, for the passenger traffic has still to be created and motor cars are peculiarly suitable for this purpose.

The local metre (3 ft. 3 3/8 in.) gauge line, Arad-Hegyaljaer, built in 1907, is operated by means of motor cars exclusively. It has for this purpose 11 petrol-electric cars, with four axles, which work an important passenger traffic. These cars were supplied by the firm Weitzer, of Arad. They contain 50 seats and are accompanied by a four-axle trailer which takes 60 passengers, so that each train can normally carry 110 passengers. The steepest up-gradient on the line is 27 per mil. The motor cars are equipped with a de Dion petrol motor directly coupled with the 45-kilowatt dynamo. The design of the cars is similar to that of the rolling stock on the Arad-Csanad Railway; they have worked irreproachably and have made it possible to meet a continual growth of the traffic. The results correspond with those obtained on the Arad-Csanad Railway, especially as regards working expenses per car-kilometre, which are 32 to 35 heller (5·14*d.* to 5·62*d.* per car-mile). It should, however, be mentioned that the delicate motor mechanism of these cars is subjected to rather considerable wear and tear, and, consequently, the cost of repairs is higher than in the case of small locomotives. Owing to the high cost of upkeep of the motor cars, but more especially also on account of the important passenger traffic developed by the motor-car service, the said narrow-gauge railway has decided to adopt *electric traction*; consequently, the local line in question, which has a length of 54 kilometres (33·5 miles), will soon be electrified.

Mr. Steinbiss. (In German.) — I can give you some supplementary information about the question of trailers. We also have trailers on the Prussian State Railway; they take 50 passengers and weigh 11 to 12 tons when empty, and 18 tons when fully loaded. The train consists of an accumulator car and of a trailer; it weighs 80 to 81 tons and runs at a speed of 25 to 28 kilometres (15·5 to 17·4 miles) on an up-gradient of 8·3 per mil. The distance it can run is about 70 to 80 kilometres (43 to 50 miles). Under such conditions, we have obtained very good results with heavily-loaded trains. What is difficult is the transhipment. The accumulator cars are used without being turned, but they must of course be shunted at the terminal stations if they are running with trailers.

The President. (In German.) — Do you wish to continue the general discussion? I would remark that noon is approaching and that it will accordingly become necessary to adjourn the meeting to this afternoon. It would in my opinion be advis-

able to close the general discussion and to pass this afternoon to the discussion of the conclusions.

Mr. Ernest Gerard, Ministry of railways, Belgium. (In French.) — I should like to make some further remarks in the general discussion.

The President. (In French.) — I call upon you to speak.

Mr. Ernest Gerard. (In French.) — Gentlemen, the conclusions of Mr. Greppi's report are very complete and I think that we can all agree to them, except as regards certain points.

The reporter remarked, at the beginning of his paper, that his list of questions had been sent to seventy-four administrations, forty-three of which answered, and twenty-six stated that they had no motor cars in use, that they never had had any in use and that they had no intention of building any.

Those twenty-six administrations seem to treat the subject lightly, and accordingly I feel compelled to raise my voice against the somewhat cavalier way in which they speak of motor cars.

From the technical point of view, the question of the type of motor car no longer needs discussion, nor does that of the details of the mechanism. All the reports presented this session, as well as those submitted to former sessions, supply sufficient information to enable locomotive and rolling-stock engineers to form a clear idea of the type of motor car or small equivalent locomotive, to be used in attaining the desired object.

In the case in question, a double object is aimed at which can be defined as follows : to have cheap light trains so as to make it possible to multiply them and so promote a supplementary traffic and meet the wishes of the public. Another object consists in replacing heavy trains, with too much accommodation, by better-utilized units.

Thus traction expenses are reduced, the traffic operated is increased, and at the same time wear and tear of the track is reduced. It is a partial transformation of certain lines of a main railroad system into light-railway lines, as regards method of operation.

Now when locomotive and rolling-stock engineers try to carry out this object, at once there is opposition from the traffic employees. The latter do not wish to follow the lead of the former. Station masters prefer big trains, so that they can place an entire compartment at the disposition of a traveller, even if he is the only one who turns up. (*Laughter.*)

It is not technical means which are lacking in order to organize the service; we have electricity, gazolene, motor cars, small locomotives of all kinds.

What then is to be done to bring about some alteration in the present state of affairs? How shake off this apathy? There is only one way. By encouraging the operating department to back up the attempts of the locomotive and rolling stock department.

But there is another enemy to economic operation.

The reporter for the United States has declared that in consequence of the labour legislation passed by Congress and by the legislative bodies of certain states, every train, however short, must have a staff of at least five employees. What is the good,

then, of reducing the rolling stock to what is strictly necessary?

I therefore think that it is advisable, either by means of premiums or otherwise, to encourage the traffic employees, especially the station masters, to second the efforts of the locomotive and rolling-stock department in promoting the use of small locomotives or of motor cars.

Nor must one be too much embarrassed by objections to details concerning the arrangement of the cars, the dimensions of the seats, etc. It is here only a question of trains running only short distances at reduced speeds, and it is evident that an economic service cannot be organized so as to offer the same conditions of comfort as a main-line service.

Locomotive engineers try to realize a saving of 15 to 20 per cent in the fuel by designing improved locomotives, but when it is possible to effect a saving of 40 per cent in the working — and this would be possible — they do not always meet with the necessary assistance from those who have in their hands the organization of the train service.

If it is necessary, in certain cases, to have both types of rolling stock available, one reduces the time any is standing idle by operating the branch line jointly with a busier part of the line. Or else, to follow the example of the Prussian State Railway, one selects, for the concentration of several motor cars, a place where several secondary lines meet, lines generally operated by some of these motor cars, the others serving as reserve. This reserve and ordinary carriages afford at a given moment a supplementary means of forming longer or more numerous trains.

I accordingly have the honour of proposing that the following clauses should be added to Mr. Greppi's conclusions :

" To encourage the staff, in suitable ways, well to utilize either the motor cars, or the trains of limited capacity composed of small locomotives and light carriages.

" Whether the attempts made by locomotive and rolling-stock engineers are wasted or not depends on this staff, and hence they can obtain from their traffic colleagues valuable assistance in attaining this important economic object." (*Applause.*)

The President. (In German.) — Later on we will read out the exact wording of the proposition just brought forward. In several quarters the wish has been expressed that the conclusions should be discussed at the morning meeting. That would only be possible if few amendments were proposed. I will leave it to you to decide whether you will examine the conclusions now already or postpone this examination to the afternoon. Subject to your consent, I am of opinion that it would be advisable to start with the conclusions this morning. We can shorten the discussion if, instead of reading out the conclusions, I ask in the case of each clause, what amendments are proposed.

The general discussion is accordingly closed and we pass on to the examination of the conclusions, the first of which runs as follows :

" 1° Automotor cars can be used in certain cases for economic services, in order to facilitate local communication at a moderate outlay, provided that the traffic conditions lend themselves to the organization of trains, carrying a regular traffic or at least one which only varies rarely

and but little, that the line is an easy one and that the goods traffic can be carried conveniently and completely on separate trains."

— Adopted.

" 2° The power of the motors of the automotor cars should present a certain margin beyond the ordinary work, so that it is possible to cope with variations of the traffic within certain ascertained limits."

— Adopted.

" 3° It would be desirable to make it possible to utilize the car independently of the motor by having either separate motor trucks, or some other device making it possible to remove and replace the mechanical part easily."

— Adopted.

" 4° From the point of view of economy of staff, that is to say, having only one traction agent, accumulator or petrol cars seem the most suitable. The types used by the administrations which have given me information represent units of too low a power. It would be desirable that investigations should be made in order to increase this power suitably, and to ensure easy and inexpensive maintenance."

Mr. Greppi, *reporter*. (In French.) — Clause 4 should be modified. In fact we now know that petrol cars of considerable power are used in America and Hungary.

I therefore propose to say :

" 4° From the point of view of economy of staff, that is to say, having only one traction agent, accumulator or petrol cars seem the most suitable. It would be desirable that the investigations should be continued in order to ensure simple design and easy and inexpensive maintenance."

— Clause 4, as amended by Mr. Greppi, is then adopted.

The President. (In French.) — " 5° As regards steam cars, it would be desirable to reduce to a minimum the care required for the boiler, and in particular to improve the semi-automatic feeding of the grate or to improve the methods of using liquid fuel."

— Adopted.

" 6° It would be desirable to recommend the investigation of small locomotives able to replace automotor cars, with the advantage of greater independence. The luggage-van locomotives, or the motor luggage-vans, represent an intermediate solution, which it seems can be suitably applied in certain cases."

— Adopted.

The President. (In French.) — We now have to decide about Mr. Gerard's proposition, which runs as follows :

" To encourage the staff, in suitable ways, well to utilize either the motor cars, or the trains of limited capacity composed of small locomotives and light carriages.

" Whether the attempts made by locomotive and rolling-stock engineers are wasted or not depends on this staff, and hence they can obtain from their traffic colleagues valuable assistance in attaining this important economic object."

Mr. de Burlet, Belgian National Sub-

urban Railway. (In French.) — I regret that I do not agree with my Belgian colleague, Mr. Gerard. It is in fact impossible for me to accept this proposition, which evidently throws a reflection on the traffic service. Such a criticism is out of place among the conclusions of an international congress; whether it be well founded or not, is a question I will not even consider.

If Mr. Gerard absolutely desires to add a clause to Mr. Greppi's conclusions, he should aim at the whole administration of the railways; not only at the traffic department, but also at the other branches of the service : locomotive and rolling stock, way and works, etc. All these services must make joint efforts in order to ensure the utilization of motor cars under the best possible conditions.

Moreover, it seems to me to be unnecessary to say so. When the Congress expresses wishes in favour of the development of a system already adopted by several administrations, is it really useful to add that railway administrations should be encouraged to investigate it and adopt it in their turn?

Consequently, if Mr. Gerard's proposition is retained, it must in any case be modified radically. (*Approval.*)

I am president of the board of the Belgian National Suburban Railway Company, and I do not desire that it should some day be possible to read in our proceedings that I have assisted in voting a conclusion which has the object of encouraging — I will not say admonishing — one of the branches of the administration of the Belgian State Railway.

Mr. Ernest Gerard. (In French.) — I by no means oppose the modification of the text which I have proposed. I must, however, observe that it is just as justifiable as for instance a text stating that drivers should receive premiums for economies in fuel and oil.

However this may be, my proposition implies no criticism of the traffic employees, but I think that these should be encouraged, either by premiums or otherwise. Why should one not do for such employees what one does in the case of drivers who receive coal and oil premiums?

We must be precise in our conclusions and not remain vague. That is the reason why I brougbt forward this proposal which has no other object but the object of economy.

Mr. de Burlet. (In French.) — I cannot say that I am satisfied with Mr. Gerard's explanations and I persist in opposing the adoption of his proposition. The Congress should limit itself to recording the results of experience acquired. This is what the reporters generally have done and the railway administrations must be left to act without marking out especially what services are to be encouraged.

Mr. Gerard has just declared that the text proposed does not imply any criticism. I accept his statement very willingly, but he will recognize that in reading his resolution carefully, this error is possible, for the request is " to encourage the staff, in " suitable ways, well to utilize either the " motor cars, or the trains of limited " capacity, *for it depends on this staff* " whether the attempts made by the loco- " motive engineers are wasted or not, and " hence they can obtain from their traffic " colleagues valuable assistance..."

Only, if this text does not imply a criticism — and I am delighted to hear it — I wonder what is its meaning and what is its use? I therefore propose that it should be rejected. Every troublesome interpretation is to be avoided.

Mr. Ernest Gerard. (In French.) — Allow me to say two words to justify the text I have proposed.

Of seventy-four administrations consulted by Mr. Greppi, forty-three sent answers. Of these forty-three, twenty-six stated that they had no motor car or equivalent small locomotive in use, that they never had any in use and had no intention of building any.

Mr. de Burlet. (In French.) — Is that the fault of the traffic department?

Mr. Ernest Gerard. (In French.) — Efforts have been made to develop an economic service. If they have failed, it is because one does not sufficiently encourage the good utilization of motor cars and of light trains.

As I have just stated, economic working could easily be developed, particularly on very busy days at places where several small lines meet.

Mr. Mauris, Paris-Lyons-Mediterranean Railway. (In French.) — I support the remarks made by Mr. de Burlet. When a question has been fully considered by a company, it is necessary that its whole staff should help towards the production of a good service. The contrary would be inadmissible.

A service cannot oppose measures which have been decided to be advisable, and a conclusion similar to that of Mr. Gerard would be a reflection on the traffic employees. The Congress hence cannot accept it.

Mr. Gerard has just stated that some administrations look upon the use of motor cars, with indifference. If such is their attitude, it is because conditions are unfavourable. The experiment made by the Paris-Lyons-Mediterranean Railway with twenty cars did not give good results, and this railway has ceased to try to develop this system of working.

We have distributed these cars among a number of minor lines while it should have been possible to group them at certain junction points where there would have been a chance of utilizing them better and of arranging for their use as reserves.

This is a question of kind, and in each case we must consider the conditions special to the district when introducing economic services.

Mr. Greppi, *reporter.* (In French.) — If many administrations have answered to the list of questions that they had no motor car in use and had no intention of building any, this is not due to ill-will on the part of the traffic employees, but because their conditions are not favourable for the proper application of the system.

The Arad-Csanad Railway, for instance, certainly is under conditions favourable for the proper utilization of a proper number of motor cars, superior even to that of locomotives, while with us it would be difficult to use more than 100 motor cars to 4,500 locomotives.

It is true that in some cases difficulties are made by certain station masters who have always been accustomed to have

their complete trains, and who show but little desire to use motor cars.

However this may be, this is a question of a detail easy to solve, and it is useless to allude to it in the conclusions.

Mr. Gerstner. (In German.) — I ask that the discussion should be closed.

The President. (In German.) — If we do not find a wording which will satisfy everybody it is preferable to abstain, remembering the Belgian motto : " *L'union fait la force* ". (*Laughter.*)

Mr. de Burlet. (In French.) — Very well, Mr. President. Let us abstain from any wording which might be equivocal.

Mr. Ernest Gerard. (In French.) — From the technical point of view, the question is solved, but the same does not apply to the utilization of motor cars. This is what should be encouraged, whether by premiums or otherwise, as is done in Prussia and elsewhere.

The President. (In French.) — I remember that Mr. Belpaire had the great merit of having recommended and introduced motor-car traction, and I perfectly understand that in this respect the Belgian State Railway has greater experience than the administration of railways in other countries. But, on the other hand, trials having been made and given up, the Congress cannot in principle assert its will; it must limit itself to enlightening all administrations while leaving them free to select what suits them best under their individual conditions.

The last wording which Mr. Gerard has handed to me speaks of the efforts to be made in order to utilize motor cars.

Mr. Ernest Gerard. (In French.) — I have just now quoted Prussia which places its motor cars at given points. Thus there are ways of utilizing them.

It must not be asserted, as a general statement, that they cannot be utilized, for this would be an error. If it is stated that certain administrations have succeeded in utilizing motor cars well by placing them at points where several small branches meet, it would be advisable to mention this in a conclusion, which would then be well-timed.

Mr. de Burlet. (In French.) — That is stated in the report.

Mr. Mauris. (In French.) — The reports mention various systems. In the trials different systems have been applied and consequently it cannot be said that the technical problem is actually solved. There are several systems to choose from.

Mr. Ernest Gerard. (In French.) — It is true that one has the trouble of choosing between different systems, but there will always be one more suitable for adoption than the others.

The President. (In French.) — Mr. Greppi's conclusions which we have just adopted recommend that investigations should be continued. These are not yet concluded and, hence, it is not expedient to draw a conclusion from them.

Mr. Ernest Gerard. (In French.) — I think that methods for utilizing motor cars exist which can ensure success, and one of these methods is to go in for special methods of encouragement which it is

advisable to adopt when economy is aimed at.

The President. (In French.) — It seems impossible to find a wording which will satisfy everybody, and accordingly we can only pass it over.

Mr. Ernest Gerard. (In French.)— Could not the bureau find a basis for an agreement? If not, I do not insist.

The President. (In French.) — I think that it is not the intention of the majority of the meeting to adopt a conclusion in the direction recommended by Mr. Gerard. (*Approval.*)

It shall accordingly be so.

Meeting held on 9 July, 1910 (morning).

Communication made by the Bureau.

The President. (In French.) — Mr. Doniol, inspector-general of bridges and roads (retired), has presented to the section a certain number of pamphlets concerning continuous-propulsion motor-car trains.

As this refers to a question which we have already dealt with, jointly with the 2nd and 5th sections, the rules do not allow us to return to it. As however the author of that pamphlet is of opinion that it is advisable to place the subject on the agenda of the next session, we will mention it in the minutes. In this way it will be brought to the notice of the Permanent Commission.

In the meantime Mr. Doniol has expressed the wish that the members of the 3rd section should obtain his pamphlet; he has deposited a number of copies of it in the office of the general secretary.

Gentlemen, we have concluded our agenda. Before we separate, allow me to thank you once more for the confidence you have kindly shown in me in asking me to preside over your labours. I have tried to direct them very impartially so as to render them profitable to all concerned. (*Applause.*)

DISCUSSION AT THE GENERAL MEETING

Meeting held on 15 July, 1910 (morning).

MR. P. WEISSENBACH, PRESIDENT, IN THE CHAIR.
GENERAL SECRETARY : MR. L. WEISSENBRUCH.
FIRST ASSISTANT GENERAL SECRETARY : MR. MÜRSET.
SECOND ASSISTANT GENERAL SECRETARY : DR. A. BONZON.

Mr. Dietler, *president of the 3rd section*, read the

Report of the 2nd, 3rd and 5th sections meeting jointly.

(See *Journal de la huitième session*, No. 5, p. 11.)

" Mr. C. Peter CLARK gave a summary of his report. He added some further information about the use of motor cars in America, which had shown some increase quite recently. It had been recognized that this system of traction could be useful on secondary lines, and also for increasing the service on main lines. The use of such cars had been experimented with, and some companies had ordered a certain number of them after trials. The motor cars used were driven by steam, with coal or oil as fuel, or by gasolene with direct mechanical transmission, or by gasolene with electric motors. Since the issue of the report seventy-five cars of the second and thirteen cars of the third type had been ordered. The question still unsettled as to the superiority of either system was whether the benefit of electric control would justify the additional weight and cost.

" Mr. GREPPI gave a summary of his report. He stated that out of forty-three administrations who sent answers to his list of questions, only thirteen actually used motor cars. These were 195 in number, 185 of which were steam cars. Some other systems had been tried.

" Small economic locomotives had also been constructed, with grates fed automatically, which had given good results.

" The maintenance of these vehicles was in general considered to be troublesome.

" Mr. Greppi added that he would be pleased to have some information from the Prussian, Hungarian and Bavarian railways about the results they had obtained with the different systems in use.

" The President requested the administrations who had any further information to give it kindly before they proceeded to the discussion of the conclusions.

" Mr. Steinbiss (*Prussian State Railway*) stated that his administration had in use 100 accumulator cars, accommodating up to 130 passengers per car. They were constructed as double cars and ran at 60 kilometres (37·3 miles) per hour. They weighed 54·5 tons (53·6 English tons) empty and 63 tons (62 English tons) loaded, and could haul a trailer weighing 18 tons (17·7 English tons) up gradients of 20 per mil. These cars ran 50,000 kilometres (31,000 miles) per year.

" The cost of operation amounted to from 45 to 65 pfennige per train-kilometre (7*d.* to 10*d.* per train-mile), including amortization of power installations. They were run by a driver and a conductor.

" Mr. Papp (*Hungarian State Railway*) used altogether 110 motor cars and special locomotives.

" The cars had room for from 40 to 96 passengers. They weighed from 20 to 37 tons (19·7 to 36·4 English tons) and ran up to 40,000 kilometres (24,850 miles) per year.

" The locomotives weighed 20 tons (19·7 English tons) and ran from 30,000 to 40,000 kilometres (18,600 to 24,850 miles) per year. The cost of operation amounted to from 36 to 42 centimes for the steam cars and to 36 centimes for the petrol-electric cars, per train-kilometre (respectively from 5·56*d.* to 6·49*d.* and 5·56*d.* per train-mile).

" Mr. Koechlin (*French Northern Railway*) stated that his company had ten steam cars in use. The engine was in the middle and the cars could run in either direction. It weighs 45 tons (44·3 English tons). One of these cars was then at the Brussels exhibition.

" Mr. Vas (*Arad & Csanad Railway, Hungary*) gave some information about the motor-car services of his company. It had fifty motor cars and three locomotives, for narrow-gauge and standard-gauge lines. More especially, the thirty-six petrol-electric cars which it owned gave every satisfaction. They were used with trailers for the express service and the ordinary service between Szegedin, Arad and Brod. The cost of operation of these cars amounted to 35 centimes per train-kilometre (5·41*d.* per train-mile); it amounted to 82 centimes (1*s.* 0·67*d.* per train-mile) in the case of the steam cars, of which a dozen were also in use.

" The company attributed the increase in their receipts, which had become particularly marked since 1906, to the introduction of motor cars.

" Mr. Lippetz (*Russian State Railway*) asked whether any technical information could be given as to the system for change of speeds adopted on the cars mentioned by Mr. C. Peter Clark.

" The President requested that the discussion should remain general; any technical details could be supplied individually to those desirous of having it.

" Mr. Kabodi (*Hungarian State Railway*) stated that on the Arad-Hegyaljaer line, 54 kilometres (33·5 miles) in length, with a gauge of 1 metre (3 ft. 3 $^3/_8$ in.), eleven petrol-electric cars were used, having four axles, holding fifty passengers and

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hauling a trailer on gradients of up to 27 per mil.

" The cost of operation varied from 33·3 to 36·4 centimes per train-kilometre (5·14*d.* to 5·62*d.* per train-mile).

" The system had resulted in a great increase in the number of passengers.

" Mr. Ernest Gerard (*Belgian government*) was surprised to find that according to Mr. Greppi's report a large number of railways had declared that they had no motor-cars in use and did not propose to try any. He attributed this to a certain hesitation, perhaps on the part of the traffic department. Conclusive results had been obtained from the technical point of view and it was a question of utilizing these properly. He desired that a final conclusion should be added, to express that the traffic department should second the efforts of the locomotive and rolling stock department in order to obtain the economic results which might be expected from motor-cars.

" Mr. de Burlet (*Belgian National Suburban Railway*) opposed this wish, as it seemed to him to express an unjustifiable criticism of the traffic departments.

" Mr. Mauris (*Paris-Lyons-Mediterranean Railway*) agreed with Mr. de Burlet and said that one had to consider in each individual case the particular conditions of the railway system before introducing such services.

" Mr. Greppi (*reporter*) also thought that the administrations which had sent negative answers might have special reasons against the use of motor-cars.

" Mr. Ernest Gerard observed that certain countries, for instance Prussia, had succeeded in working out systems for utilizing motor-cars well, so as to obtain the best economic results.

" The President then proposed the discussion of Mr. Greppi's conclusions.

" Mr. Greppi, in consequence of the information which had been supplied to the meeting, proposed to modify conclusion 4° as follows :

" 4° From the point of view of economy of staff, that is to say, having only one traction agent, accumulator or petrol cars seem the most suitable. It would be desirable that the investigations should be continued in order to ensure simple design and easy and inexpensive maintenance."

" Mr. Greppi's proposed conclusions were then adopted, for submission to the general meeting, in the following form :

The President. — The following are the

CONCLUSIONS.

" 1° Automotor cars can be used in cer-
" tain cases for economic services, in or-
" der to facilitate local communication at
" a moderate outlay, provided that the
" traffic conditions lend themselves to the
" organization of trains, carrying a re-
" gular traffic or at least one which only
" varies rarely and but little, that the line
" is an easy one and that the goods traffic
" can be carried conveniently and com-
" pletely on separate trains.

" 2° The power of the motors of the
" automotor cars should present a certain
" margin beyond the ordinary work, so

" that it is possible to cope with variations " of the traffic within certain ascertained " limits.

" 3° It would be desirable to make it " possible to utilize the car independently " of the motor by having either separate " motor trucks, or some other device " making it possible to remove and re- " place the mechanical part easily.

" 4° From the point of view of economy " of staff, that is to say, having only one " traction agent, accumulator or petrol " cars seem the most suitable. It would be " desirable that the investigations should " be continued in order to ensure simple " design and easy and inexpensive main- " tenance.

" 5° As regards steam cars, it would be " desirable to reduce to a minimum the " care required for the boiler and in par- " ticular to improve the semi-automatic " feeding of the grate or to improve the " methods of using liquid fuel.

" 6° It would be desirable to recom- " mend the investigation of small locomo- " tives able to replace automotor cars, with " the advantage of greater independence. " The luggage-van locomotives, or the " motor luggage-vans, represent an inter- " mediate solution, which it seems can be " suitably applied in certain cases."

— The conclusions were confirmed by the general meeting.

4TH SECTION — GENERAL

OPENING MEETING

4 July 1910, at 4.50 p. m.

PROVISIONAL PRESIDENT, MR. WEISSENBACH,
MEMBER OF THE PERMANENT COMMISSION OF THE CONGRESS.

The President. (In French.) — Gentlemen, the Permanent Commission has asked me to preside while we appoint the bureau of the 4th section.

I propose that we should appoint as our president Mr. C. COLSON, member of the Institute, inspector-general of bridges and roads, State councillor of France, and member of the Permanent Commission of the Congress, whose profound knowledge of railway matters is known to all of you. (*Unanimous approval and applause.*)

I also propose to you to appoint the following :

1° As vice-presidents : Mr. Evelyn CECIL, member of Parliament (England), director of the London & South Western Railway and member of the Permanent Commission of the Congress; Mr. J. V. Mendes GUERREIRO, engineer, inspector-general of bridges and roads of Portugal and member of the Permanent Commission of the Congress; Mr. Fairfax HARRISON, vice-president of the Southern Railway (United States of America) and member of the Permanent Commission of the Congress; and Mr. V. TIMONOFF, privy councillor, professor, engineer of ways of communication, engineer of bridges and roads, manager of the statistical department of the Russian ministry of ways of communication. (*Applause.*)

2° As principal secretary : Mr. BLOCH, chief engineer, assistant traffic manager of the Orleans Railway of France. (*Applause.*)

— Mr. WEISSENBACH vacated the chair which was then occupied by Mr. COLSON, who thanked the meeting for honouring him by calling upon him to preside over their labours. (*Applause.*)

— On the proposal of the president, the SECTION then appointed the other members of the bureau and drew up provisional agenda.

SECTION IV : GENERAL

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QUESTION XIII

RAILWAYS AND WATERWAYS

The investigation of the influence of waterways considered as feeders and as competitors, on railways.

Reporters :

Great Britain. — Mr. G. R. Jebb, M. Inst. C. E., member of the council of the Institution of civil engineers, chief engineer of the Shropshire Union Railways and Canal Company and of the Birmingham canal navigations.

America. — Mr. William E. Hoyt, member American Society of civil engineers, special engineer, New York Central Lines.

Other Countries. — Mr. C. Colson, general inspector of bridges and roads, State Concillor of France, and Mr. Louis Marlio, engineer of bridges and roads.

QUESTION XIII

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Report No. 2 (all countries, except Great Britain and America), by Messrs. C. Colson and L. Marlio. (See English edition of the *Bulletin* of March, 1910, p. 1125.)	XIII — 27
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N. B. — See also the separate issues (in red cover) Nos. 3, 26 and 38.

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REPORT N° 1

(Great Britain)

By G. R. JEBB, M. Inst. C. E.,

MEMBER OF THE COUNCIL OF THE INSTITUTION OF CIVIL ENGINEERS,
CHIEF ENGINEER OF THE SHROPSHIRE UNION RAILWAYS AND CANAL COMPANY
AND OF THE BIRMINGHAM CANAL NAVIGATIONS.

Great Britain and Ireland.

To enable me to compile this paper, the general secretary of the Congress Mr. Weissenbruch, kindly issued at my request, a list of questions, bearing on the question, twenty-two in number (see appendix), to forty-one railway companies in the United Kingdom of Great Britain and Ireland, of which twenty have replied, and it appears from the replies received that the influence of waterways, considered as feeders, on railways is negligible except in the case of the Birmingham Canal Navigations.

This canal system is of such an exceptional character that I will give a short description of it and its influence on railways.

The Birmingham Canal system is a network of canals chiefly in the mining districts of South Staffordshire known as the black country, but extending into Warwickshire and Worcestershire and its character is in many ways unique.

The total length is about 159 miles exclusive of some 550 private basins and short branches. The Canal Company do not act as carriers.

Works of almost all descriptions such as ironworks, mills, forges, brickworks, collieries, chain and anchor works, nail works, tube works, galvanizing works, chemical works, have been built from time to time on the banks of the canal and

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these works form almost a continuous line for many miles between Birmingham, Wolverhampton and other places.

A large number of seams of coal are being worked under and near the canal — (one of them 30 feet in thickness), in consequence of which the canal and works often subside from 15 to 20 feet and in some places as much as 30 feet — nearly the whole area between Birmingham and Wolverhampton and in the neighbourhood of Dudley is honeycombed by coal workings.

A large number of the works on the banks of the canal have no direct railway communication, in consequence of which, twenty-six railway basins, or places for the direct transhipment of goods from boats on the canal to trucks on railway sidings, and *vice versa* have been made.

These railway basins are of great advantage to the railway companies, as they shorten the distance traffic has to be boated to and from the railway.

Railway basins have been constructed by the following railway companies *viz.* :

The Great Western Railway Company;
The London & North Western Railway Company;
The Midland Railway Company.

In many cases, the railway companies have made private lines to the basins and constructed warehouses, sheds, cranes, etc., for the accommodation of traffic. The Birmingham Canal may, therefore, be considered as a valuable feeder to the railway companies; it is also a competitor, but chiefly for short distances and principally for the conveyance of coal and bricks.

The total amount of traffic interchanged between the above mentioned railways and the Birmingham Canal is on an average about 1,202,400 tons per annum.

The annual traffic on the canal is roughly 8,000,000 tons or about two ninths of the total traffic of all inland navigations of the United Kingdom of Great Britain, of this 8 million tons about one half is coal, about four fifths of which goes to works on the banks of the canal itself, an average distance of something like 8 miles.

Of the forty-one railway companies in the United Kingdom of Great Britain and Ireland about one sixth of them have inland waterways to compete with for traffic the more important being.

1° *The London & North Western Railway Company*, the canals competing being as follows :

The Lancaster Canal, Huddersfield Canal, Ashton Canal, St. Helens Canal, Shropshire Union Railways and Canal, Birmingham Canal Navigations, Manchester Ship Canal, Manchester Ship Canal (Bridgewater Undertaking), Leeds & Liverpool Canal, Weaver Navigation, Trent & Mersey Navigation, Macclesfield Canal, Staffordshire & Worcestershire Canal, Coventry Canal, Warwick & Birmingham Canal, Warwick & Napton Canal, Oxford Canal and Grand Junction Canal.

2° *The Great Western Railway Company :*

The River Thames & Kennet & Avon Canal, Wiltshire & Berkshire Canal, Oxford Canal, Grand Junction Canal, Gloucester & Berkley Canal, Severn Navigation, Lower Avon Navigation, Staffordshire & Worcestershire Canal, Worcester & Birmingham Canal, Stourbridge Canal, Birmingham Canal Navigations, Stratford-on-Avon Canal, Shropshire Union Railways & Canal Company, Bridgewater & Taunton Canal, Grand Western Canal, Brecon & Abergavenny & Monmouthshire Canals, Swansea Tennant & Neath Canals and Glamorgan & Aberdare Canals.

3° *The Midland Railway Company :*

The Warwick & Birmingham Canal, Birmingham & Warwick Junction Canal, Birmingham Canal Navigations, Sharpness New Docks & Gloucester & Birmingham Navigation, Trent & Mersey Canal, Trent Navigation, Ashby Canal, Coventry Canal, Cromford Canal, Chesterfield Canal, River Severn Navigations, Lydney Canal and Nottingham Canal.

4° *The Lancashire & Yorkshire Railway Company :*

The Leeds & Liverpool Canal, Bridgewater Canal, Aire & Calder Navigation, Calder & Hebble Navigation, Rochdale Canal, Manchester Ship Canal, Barnsley Canal, Sheffield & South Yorkshire Canal, Douglas Navigation, Manchester Bury & Bolton Canal, Ashton Canal, Peak Forest Canal, Macclesfield Canal and Chesterfield Canal.

There are 177 canal systems in the United Kingdom representing a length of about 4,673 miles, of these 46, (1,114 miles) are either owned, or more or less controlled, by railway companies, the most important being :

The London & North Western Railway Company, who own or practically control the Lancaster, Huddersfield, St. Helens, Shropshire Union and Birmingham Canals.

The Great Western Railway Company :

The Kennet & Avon, Stratford-on-Avon, Bridgewater & Taunton, Grand Western, Brecon & Abergavenny & Monmouthshire, Swansea and Stourbridge Extension Canals.

The Midland Railway Company :

The Ashby and Cromford Canals.

The Great Central Railway Company :

The Ashton, Peak Forest, Macclesfield & Chesterfield and Sheffield & South Yorkshire Canals.

The Great Northern Railway Company :

The Grantham & Nottingham Canals and River Witham Navigation.

The Lancashire & Yorkshire Railway Company :

The Manchester Bury & Bolton Canal and Branches.

The North Eastern Railway Company :

The Pocklington Canal & River Ure and River Derwent Navigations.

The North Staffordshire Railway Company :

The Trent & Mersey, Caldon Branch, Newcastle Branch, Burslem Branch, Macclesfield Branch and Leek Branch Canals.

The Caledonian Railway Company :

The Firth & Clyde Navigation.

The North British Railway Company :

The Monkland Canal.

The Midland Great Western Railway of Ireland Company :

The Royal Canal.

Canals and waterways compete for traffic with the railways companies between London, Liverpool, Leeds, Bristol, Goole and the Midland Counties of England, East and West Coast of Scotland, Waterford, Dublin and Limerick, the majority of them are toll takers only, in a few cases the owners act as carriers as well as toll takers *viz.* :

The Manchester Ship Canal (Bridgewater Undertaking), Shropshire Union Railways & Canal, Aire & Calder Navigation, Trent Navigation, Glamorganshire Canal, Leeds & Liverpool Canal, Rochdale Canal, Grantham Canal, Nottingham Canal, Linton Lock Navigation, Trent & Mersey Navigation.

All the railway companies whose opinion has been asked are agreed that, speaking generally, a regular and efficient service is maintained on the waterways, but of course the service is dependent on the traffic which is presented, the service on the waterways is liable more or less to interruption by frost and drought, and on some of the canals this interruption is considerable.

The railway companies have to fix their rates having regard to the competition by the various waterways, and carriers on the canals get as near the rates charged by railway companies as they can between competitive points, but generally speaking,

the rates by canal are lower than by railway; in some cases there are agreed differentials varying in amount.

On the majority of the railways, both collected and delivered and also station to station rates are in operation, which include the services of loading and unloading. The rates for mineral class traffic such as coal, bricks, lime, limestone, etc., are exclusive of these services as well as cartage.

Canal companies and private carriers on canals, in fixing their charges take into account the classification applicable to all canal companies. For heavy traffic, they quote exceptional rates according to circumstances.

Rates by canal are quoted both exclusive and inclusive of loading and unloading according to circumstances and nature of traffic, they also include, if required, storage accommodation at terminal points. Rates are also quoted at owner's risk, as well as at carrier's risk. In some cases, carriers undertake the collection and delivery of traffic and quote inclusive rates for such services.

In cases where canal companies are carriers, they have fixed rates chargeable to all parties alike, but owners of private boats are at liberty to make special bargains for cargoes as they arise without being subject to the Railway and Canal Traffic Acts as regards undue preference.

The greatest load which can be carried in a vessel navigating waterways (with the exception of the Manchester Ship Canal) competing with railways is 250 tons and the smallest 18 tons, but on the bulk of the canals the greatest load may be taken as 25 tons. The motive power used is horse haulage on most of the narrow canals, and steam on the wider canals. Experiments with a view to the adoption of more economical and efficient methods of traction have been conducted on the Birmingham Canal by arranging trains of ten compartment boats each boat carrying about 12 tons and towed by a steam tug and although the cost was found to be considerably less then by horse traction, the obstruction caused at the bends in the canal and at the locks and bridges was so great that this mode of haulage was not adopted.

This method is working satisfactorily on the Aire and Calder Canal where all the circumstances are specially favourable for its use.

Waterways compete for most descriptions of traffic which are usually conveyed on the railways by goods train, but in the main competition is in such traffics as coal, iron, bricks, timber, grain and manure. The canals are equipped with warehouses, cranes, etc., sufficient to meet the requirements of the traffic passing along them, such accommodation in the majority of cases being provided by the canal companies, but in some instances, private canal carriers provide their own warehouses and appliances.

The canals are used for the conveyance of agricultural produce only to a very small extent.

Practically in all cases where the railways compete with the canals, goods collected by the former one day are conveyed and delivered at their destination the

following day, whereas by canal, except for very short distances, transit takes two or more days.

There is a decided tendency for consignments to get smaller every year, traders live more from hand to mouth than formerly, quick despatch of goods is essential as the prevailing method is for traders to keep their stocks as low as possible and often to order their supplies by telegraph or telephone. Between all important towns there is on railways a one day service, and goods collected one day are delivered the next, for example :

London to Birmingham. . .	111 miles.	London to Leeds	186 miles.
— to Manchester . . .	183 —	— to Glasgow	400 —
— to Liverpool. . . .	199 —	— to Dublin	314 —

Speaking generally, the competition between the railways and waterways does not appear to be either increasing or diminishing, and although the competition with the water carriers is in some districts more keen than formerly, the railway companies do not appear to have lost ground.

In the cases of traffic brought by canal carriers to docks for shipment, there is no delay in transferring traffic from barge to ship provided the vessel for which the goods are intended has arrived and is ready to load. In cases of goods received from ship, canal carriers so arrange that their boats are not placed alongside until the vessel is ready to make delivery of the goods thereto, but if they are dealing with small loads to be collected from different vessels, some delay does arise.

Crane power or manual labour is the usual method of transhipment from railway to waterway or *vice versa*, it is impossible to give the cost of transhipment for the various classes of traffic as the services to be performed are so varied. The classes of goods most liable to injury by transhipment are glass, china, earthenware and coal.

With regard to sea competition. Practically all the railways are affected in this respect — traffic is conveyed between all the ports by coasting services — for instances coal and other traffic from South Wales to Liverpool and London and also from the Northern Ports to London, goods from London to Hull and through Hull to towns in Lancashire and Yorkshire *via* the East Coast. London to Liverpool and Manchester, to towns in Lancashire, Cheshire and Yorkshire *via* the West Coast — London, Liverpool, Manchester, Cardiff, Swansea, Bristol and numerous other ports to Scotland.

Speaking generally, the influence of waterways as they exist at the present time, both as competitors and feeders to railways, is not so great as was the case thirty or forty years ago with the exception of the Manchester Ship Canal to which I refer later. Since those times railway freights generally have been lowered, particularly in regard to those commodities which would be likely to pass by a water route.

The railways also give greater facilities for the conveyance of traffic now than was the case many years ago, when the competition with canals was much keener than to-day.

It is probable that if waterways were enlarged and improved and more efficient services were given than at present, it might lead to some reductions in railway rates between points for specific traffic, but this would entirely depend on the extent of the enlargement and improvement.

Manchester Ship Canal :

This canal is of such an important character that I report separately upon its influence on railways.

The Manchester Ship Canal was completed and opened on the 1 January 1894 and is 35 ½ miles in length. It begins at Eastham on the Cheshire Shore of the river Mersey about 6 miles from Liverpool and ends at Manchester.

The ordinary dimensions of the canal are as follows :

Bottom width from Eastham to Barton (30 ½ miles)	120 feet.
— — Barton to Manchester Docks (5 miles)	170 —

The width at water level varies considerably, but the ruling width is as follows :

From Eastham to Barton	200 feet.
— Barton to the Docks	250 —
Depth of water	28 —

Large docks, quays and warehouses have been constructed in Manchester for the accommodation of the largest cargo carrying vessels.

The effect of this Ship Canal as competitors with the railways, is that oversea traffic which if the Ship Canal had not been made would have been landed at Liverpool, Birkenhead, Garston and other ports, thereby giving the railway companies the carriage to Manchester itself and other towns, is now delivered at Manchester by ocean going vessels.

The Ship Canal is also in competition with the London & North Western and other railway routes *via* Holyhead, Fleetwood, Heysham, Liverpool, etc., for Irish traffic to and from Manchester and the surrounding district.

The Ship Canal feeds the railways through Manchester Docks in respect of traffic for inland towns, but the railway companies get less mileage than before the canal was made.

Sea freights from Manchester Docks are invariably the same as to Liverpool, but when landed at the latter port, dock and town dues are levied in addition to the sea and rail freights, and the Ship Canal Company cut their tolls and other charges, so that the total expense through Manchester Docks is never more than if the traffic had been conveyed *via* Liverpool, while in the majority of cases, the expense through Manchester Docks is less.

At the time I write, May 1909, a Royal Commission on canals and waterways in

Great Britain and Ireland is taking evidence on the following subjects which have been referred to it :

1° As to the present condition and financial position of canals and waterways;

2° As to the causes which have operated to prevent the carrying out of improvements by private enterprise, and whether such causes are removable by legislation;

3° As to facilities, improvements and extensions desirable in order to complete a through communication by water between centres of commercial, industrial, or agricultural importance, and between such centres and the sea;

4° As to the prospect of benefit to trade of the countrycompatible with a return on the probable cost; and

5° As to the expediency of canals being made or acquired by public bodies or trusts, and the methods by which funds for the purpose could be obtained or secured; and what should be the system of control and management of such bodies or trusts. The commission was appointed in March 1906.

Representatives of various trades, of County and Borough Councils and other authorities haven given evidence advocating the making of four new main canals from the Midlands near Birmingham to the sea *viz.* :

To the mouths of the rivers Mersey, Severn, Thames and Humber; but however much one witness differed from another, as he did on many important points, in his advocacy of making these canals, all the witnesses agreed that the public could not be depended upon to find the money for such improvements without a guarantee either from the State or from County or Borough Councils. It is clear from the evidence that the object of most of the witnesses was merely to use the improved waterways in an endeavour to bring down railway rates.

Should these four canals to which I have referred be made, I feel sure that no fair return on the capital expended would be possible.

Indian and Colonial Railways.

Of the nine railway companies in the Indian Empire, all of them more or less have river navigation and sea route services to compete with for traffic.

The Southern Mahratta Railway Company, Limited, have the sea route from Mormugo to Bombay.

The Oudh and Rohilkhand Railway, the India General Navigation and Railway Company, Limited, the rivers Ganges, Surjoo and Gogra.

The North Western Railway (Lahore), the native boats on the river Indus chiefly between Multan and Sukkur and places situated on the river between those two points, also the Tuleli Canal which passes close by the City of Hyderabad and through the Country Southwards.

The Madras & Southern Mahratta Railway Company, Limited (Madras Section), Inland Canals between Madras and Coconada.

The East Indian Railway Company & The Eastern Bengal State Railway System. — The India General Navigation and Railway Company, Limited and the Rivers Steam Navigation Company, Limited, whose steamers navigate the rivers Ganges and Bhagirathi.

The India General Navigation and Railway Company, Limited, and the Rivers Steam Navigation Company, Limited, are under the control of the Eastern Bengal State Railway System in respect of the combined services through which through booking arrangements exist, but the railway has no control over their direct services.

The other waterways are not under the control of railway companies.

Waterways compete with railways for traffic between Goalundo and Dibrugarh (Assam), Calcutta, Dighaghat, and Agodghyaghat on the rivers Ganges, Surjoo and Gogra, between Azimgunge and Buxar on the rivers Ganges and Bhagirathi, between certain stations on the Southern Mahratta Railway, and Bombay over the whole section, Madras to Coconada, the sea route from Mormugo to Bombay the Tuleli Canal which runs close by the City of Hyderabad Southwards, chiefly over two of its branches *viz.* :

The Mirwah which passes close by Badin and Nasirwah Eastward through Thar and Parkar District and the sea route Murmugo to Bombay.

The owners of the waterways with the exception of those belonging to the state act as carriers and toll takers.

Native boats as far as is known are exempted from all tolls.

Except in the dry season, there is a regular and efficient service maintained by the waterways. Railway rates, in the majority of cases, have to be adjusted to meet the competition by water and only where the time occupied in transit is of no importance is traffic carried by waterways.

Both collected and delivered and also station to station rates are in operation on the railways.

The rates by railway and waterway are by no means the same, as the steamer companies have quite a separate tariff and charge accordingly. The steamer companies rates are not subject to any statutory control as the railway rates are *viz* : by a schedule of maximum and minimum rates to be charged, which is fixed by government. The rates charged by the steamer companies are invariably lower than the railway rates.

Native boatmen on the return journey to their home stations, rather than work their boats down empty, or wait for better conditions, will carry a cargo for little or no profit, or for merely for an allowance of the grain carried sufficient for their daily food.

In most cases, there is an agreed classification and tariff among the water carriers; freight charges are also fixed by agreement between the owners of goods and the carriers.

In some cases, the rates are at carrier's risk; alternative rates are also quoted at owners risk and are inclusive of loading and unloading and cover the provision of terminal accommodation for a specified period.

The general rule is that traffic for conveyance by water is tendered at and removed from the Water Carriers Depôts.

Special bargains or reductions are made in the rates by the Water Carrying Companies for large quantities, but speaking generally, the same rates are charged to all parties alike, the loads carried vary with the different description of boats, from 2 to 40 tons on the river Indus, from 1 $^{1}/_{2}$ to 6 tons on the Tuleli Canal and up to a 1,000 tons by steamers plying on the rivers Ganges and Bhagirathi, the motive power used on the waterways is steam, sails, oars, propelling poles and punting.

The classes of traffic chiefly competed for by the waterways is salt, betel nut, spices, sulphur, glass, agricultural produce and other miscellaneous articles, but when the water rises in the rivers during the monsoons, they carry grain and seeds in large quantities.

Only in a few cases do the steamer companies provide warehouses and cranes *viz.*: in Calcutta, Bhagalpur, Mormugo and Bombay; at Ajodghyaghat, goods are warehoused in part of the Oudh & Rohilkhand Railway Goods Shed.

The following is a comparison of the time occupied in conveying goods between the undermentioned stations by rail and by steamer during the dry and rainy seasons.

		Dry season.		*Rainy season.*	
	Distance.	Rail.	Steamer.	Rail.	Steamer.
Howrah to Bhagalpur. . . .	265 miles.	3 days.	10 to 13 days.	3 days.	6 days.
— to Dighaghat . . .	344 —	4 —	13 to 15 —	4 —	8 —
— to Patma.	332 —	4 —	13 to 15 —	4 —	8 —

Between Mormugo and Bombay, native boats take eight to ten days for the journey, steamers about two days, the railways less. By water, from Assam to Ajodghyaghat fifteen days and from Calcutta fourteen days, by railway, ten days Assam to Ajodghyaghat and four days from Calcutta to the same place.

The average weight of consignments cannot be determined as they vary considerably.

Competition between railways and waterways is increasing with a few exceptions *viz.*: On the river Indus, chiefly between Multan and Sukkur and on the other waterways in connection therewith where it has steadily decreased for years past. On the rivers Ganges, Surjoo and Gogra, it is increasing, as water carriers are building more steamers.

On the rivers Ganges and Bhagirathi, cargoes are dealt with in flats, which are used as floating warehouses.

These flats are dropped by the steamers at the different depôts and remain there often for several days until they are loaded up. Some of the larger steamers carry cargo on their lower decks, in which case the steamers have to stay at the depôt until the cargo is loaded and unloaded.

To a certain extent the waterways act as feeders to the railways in all classes of goods but chiefly grain and seed.

Traffic is not exchanged between railway and waterway as part of a through route, but in regard to cases where special arrangements are made with the water carriers for combined carriage, traffic is carried through at the combined agreed rates.

Transhipment is performed mostly by manual labour, crane power being provided in a few cases, the cost depends on the distance goods have to be conveyed from waterway to railway and *vice versa*. Goods liable to injury by transhipment are as follows : Iron castings, cast iron railings, casting brass, machinery, glassware and chinaware, cement and cement castings, all goods in liquid condition, also in casks, articles of art pottery and earthenware of all kinds, articles made of clay, tea seeds, stationary, marble or plaster of paris, spirits in jars, billiard tables, butter in tins or casks, etc.

Railway traffic is affected by sea competition to no appreciable extent.

The waterways, as they now exist, interfere only to a slight extent with the earnings of the railways, as although they have taken away some traffic from them, they have brought traffic which the railways would not have had but for the waterways.

It is generally considered that if the waterways were enlarged and improved, considerably more traffic would be diverted from the railways than at present.

New South Wales Government Railways.

The conditions in New South Wales renders competition by the rivers with the railways, comparatively ineffective.

The river courses run long distances, but owing to periodical droughts and the absence of mountain chains from which the rivers might be fed, the duration of navigation is uncertain. The principal districts served by the water carriage offering competition are in the South West and North West, or Hay (South West), 461 miles from Sydney by rail, and Bourke (North West) 509 miles from Sydney by rail.

Western Australia Government Railways.

The only navigable waterway in Western Australia is the Swan river (really an arm of the sea) between Freemantle and Perth a distance of about twelve miles and the waterway is owned and controlled by the Government. Two steamship companies ply for traffic and act as carriers by permit from the Government, but no regular service is maintained, it being entirely dependent upon the shipping, the rates charged are elastic and made to suit special circumstances.

Warehouses and cranes are provided at Perth by the steamship companies, the time occupied in conveyance by river varying according to circumstances, but it does not compare favourably with the railway service. The railway is hardly affected by competition from the steamship companies, and if the Swan river were deepened, Inter-State boats would probably bring cargo to Perth direct, instead of discharging at Freemantle, but this would not materially affect the railway rates.

Tasmanian Government Railways.

In Tasmania, there are no waterways owned privately or by companies, but it is intersected by large rivers.

In some cases, the railway runs along the river banks and along the sea coasts. There is thus water competition in both instances. The railways have also to contend with water competition on the main line which bisects the Island from North to South.

The two principal ports are connected by rail (133 miles) but though the distance by sea is much greater, the competition is effective in the case of goods which do not require quick transit, and special rates have to be quoted to secure such traffic.

Wherever the water competes, the railway rates are made lower than ordinary mileage scale.

From Hobart (the capital) to New Norfolk (26 miles) the railway, road and river run parallel, and there is keen competition for passengers and goods — principally fruit: rail transit being quicker, it takes the major portion of the traffic, but at low rates approximating to those of the steamers. For parcels and small lots of goods, the rail rates include delivery but not collection.

The steamer companies do not deliver beyond the wharves.

Natal Government Railways.

There are no waterways in Natal which compete for traffic against the railways.

APPENDIX.

Detailed list of questions relating to question XIII.

1. Do any waterways compete for traffic with your railway? if so, state the titles of waterways so competing.

2. Are any of the competing waterways under the control of the railway company? if so, state which.

3. Between what points do the waterways compete?

4. *a*) Do the owners of the waterways act as carriers or as toll takers only?
   b) Is there a regular and efficient service maintained by water?
   c) Is service liable to interruption from frost and drought?

5. What is the effect of the competition on railway rates?
   a) Particularly on special large quantities of traffic passing between competitive points when time occupied in transit is of no importance.

6. Are the rates by waterway and railway the same? if not, how do they differ.
   a) Do the rates on your railway include loading, unloading, collection and delivery in the various towns, or are the rates charged for conveyance only from forwarding point to destination?
   b) Is there an agreed classification and tariff amongst the water carriers?
   c) Are the rates by water inclusive or exclusive of loading and unloading? do they cover the provision of terminal accommodation, and are the rates at owner's or carrier's risk?
   d) Do the water carriers undertake the collection and delivery of traffic? if so, are inclusive rates quoted.
   e) Are the same rates charged by water carrying companies to all parties alike for similar goods carried under equal conditions and circumstances, or are special bargains made for quantities as they arise.

7. What is the greatest load which can be carried in a vessel navigating each competing waterway?

8. What is the motive power used on the waterways?
   a) Are any experiments being conducted at the present time with a view to adoption of more economical and efficient methods of traction on the waterways.

9. For what classes of traffic do waterways chiefly compete?
   a) Are the waterways well equipped with up to date terminal facilities, *e. g.* warehouses, cranes, etc., and by whom are these provided?
   b) To what extent are the waterways used for agricultural produce?

10. What is the average time occupied in collecting, conveying, and delivering traffic by waterway and railway respectively between the chief towns and ports on your railway?

11. What is the average weight of each consignment of the more important classes of traffic?

12. Is the tendency for consignments to get smaller?

13. Is quick despatch often essential? If so, give examples.

14. Do you find the competition by waterway is increasing or diminishing?

a) Is the traffic on the waterways in competition with your railways increasing or diminishing?

b) Are road motors taking the traffic from the railways and waterways to any extent?

15. To what extent do vessels have to wait for loading and discharging cargo?

16. Do the waterways act as feeders to the railway? if so, to what extent, and for what classes of traffic?

a) Is traffic exchanged between your railway and the waterways as part of a through route? — if so, is such traffic conveyed at agreed through rates?

17. Describe methods of transhipment.

18. What is the cost of transhipment for various classes of traffic?

19. What classes of traffic are liable to be injured by transhipment?

20. In what respects is your railway affected by sea competition?

21. State generally your views on the influence of waterways as they exist today both as competitors, and feeders, on your railway.

22. What would be the probable effect on your railway rates if the waterways were enlarged and improved?

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REPORT N° 3

(America)

By WILLIAM E. HOYT,
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SPECIAL ENGINEER, NEW YORK CENTRAL LINES.

In collecting information relating to the competition of railways and waterways in the United States, I am indebted to Mr. Weissenbruch, the General Secretary of the permanent Commission of the Congress, for material assistance.

Early in March, 1908, at my request, a list of questions was sent by him to the officials of those railroads which were thought to be most affected by the competition of waterways, but, up to the first of October following, only ten replies had been received to the questions submitted.

Mr. Weissenbruch, upon being informed of this, issued another circular letter early in November, 1908, which was sent to the administrative officials of the railroads previously addressed. This letter strongly urged that immediate attention be given to the subject under investigation, and requested that replies be sent at once in order that the work of collecting information should not be delayed.

In answer to this last appeal, only two additional replies were received up to July, 1909.

In consequence of the difficulty of obtaining sufficient data from railroad companies on which to base a report, the writer was obliged to make independent investigations and to have recourse also to material collected by the United States Census, the United States Engineers, together with compilations by Government Commissions containing information relating to the subject.

Briefly summarized, conditions in the United States in reference to railroads and waterways may be described as follows.

Our railroads aggregate in length some 232,000 miles, while there are in operation only 2,190 miles of canals out of a total of 4,500 miles originally constructed.

Seventeen of these canals, having a total length of less than 200 miles, are owned by the United States Government. There are twelve State canals, aggregating 1,360 miles in length, and sixteen private canals, with a total length 632 miles.

The 2,444 miles of canals now abandoned represent an original cost of over $80,000,000.

Rivers.

There are nearly 300 rivers in the United States, used for navigation, and these have a navigable length, in all, of 26,400 miles.

Those tributary to the Atlantic Ocean are approximately 5,300 miles long, while those flowing into the Gulf of Mexico, exclusive of the Mississippi and its tributaries, have approximately the same number of miles navigable.

The Mississipi alone, with its tributaries, has a total of almost 13,900 miles.

Rivers flowing into the Pacific Ocean are 1,600 miles in length, while the Red River of the North, running northerly into Canada, has about 180 miles navigable.

Coast line.

For coastwise transportation, we have in the United States an Atlantic coast line more than 2,000 miles in lenght, and nearly 1,900 miles along the Gulf of Mexico. The Pacific Coast line is upwards of 1,800 miles long, making a grand total of 5,700 miles.

In addition to this, there are extensive ocean-inlet, bay and sound routes with a meandering coast length of over 64,000 miles.

Among these are the Gulf of Maine, Long Island Sound, Delaware Bay and Chesapeake Bay on the Atlantic coast, and Puget Sound on the Pacific coast.

Lakes.

There are also the Great Lakes, which constitute the most extensive and important system of waterways in the world.

These have a United States coast line of nearly 2,800 miles, or, with indentations, a length of over 4,300 miles.

Considering the extent of waterways in the United States, it would seem that they should exert a very considerable influence upon railroad transportation throughout the entire country. We find, however, that there are certain natural limitations and artificial conditions which act as strongly restraining influences in the matter of competition with railways.

Our largest rivers do not flow in the direction of the great traffic movement across

the continent, and there is also a lack of correlation in the various water routes. We find moreover an entire absence of organization in the system of water transportation.

Through freight constitutes, by far, the greater part of the traffic of the country, and this the railroads are well prepared to handle by reason of their thorough standardization und unification, together with the perfection of their rolling-stock.

Our waterways, on the contrary, are widely divided by physical characteristics and handicaped by diversities of floating equipment. Unfortunately too, nearly all the river and canal routes have channels of greatly restricted depth and width, which confine transportation to boats of small capacity.

Another serious limitation is the fact that many of our most important waterways are closed to navigation for approximately five months in the year by ice.

In addition to this, our river channels are continually obstructed by rapidly accumulating deposits of silt, which render inland navigation extremely precarious and uncertain.

In times of drought too, the transportation service is liable to protracted periods of interruption.

Effect of competition.

In estimating the influence of waterways on transportation rates, we find wide differences in the effect of canal, river, ocean and lake competition.

Canals.

In former years, canals were of far greater importance in this respect than at present. Even the Erie Canal, the longest in the United States, has, at present, probably no effect whatever on either local or through rates.

Rivers.

Rivers, on the contrary, have an appreciable influence, depending upon their navigable length, depth and floating equipment. It must be said, however, that only local traffic is seriously affected generally, except in the transportation of coal and lumber, which will be referred to hereafter.

The great lakes.

On the great lakes, we find the effect of water competition to be more marked than on canals or rivers. This is partly due to the length of the routes, the unrestricted depth of water and the excellent harbor facilities, all of which allow the use of large vessels of great tonnage capacity. For this reason, the cost of transportation is small and we find water rates on some classes of commodities so low that the railroads cannot compete with the lake lines.

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The effect of this has been to force all the important trunk lines of railroads to secure control of lines of vessels on the great lakes in order to stifle competition as much as possible, and, in this, the railroads have been successfull as to most freight, the exceptions being ore, coal and, to somer extent, lumber.

An important result of the great lakes competition is shown in a series of decisions by the United States Supreme Court and the Interstate Commerce Commission, by which railroads are permitted to charge a lower rate to water competitive points than to points not affected by water competition, although the haul may be longer in the former case.

Coast traffic.

The business of water carriers along the coast is very large. There are regular lines of steamships between north Atlantic and south Atlantic ports, as well as coasting steamers running between intermediate ports. Sailing vessels also carry cargoes of considerable size, and there are tramp steamers in addition, which, until recent years, secured an important share of the coastwise traffic; but the business of these apparently is becoming of less importance year by year.

Taken altogether, however, the volume of freight carried by coastwise water lines is of great magnitude, and the rates on bulk commodities, as well as on package freight, to a considerable extent, are so much below railroad rates as to put the railroads practically out of the field, in the way of competition for the greater part of the traffic.

We find also that railroad interests have secured control of important coastwise lines to some extent, so that railroads and water lines are members of traffic associations which make joint rail and water rates, thereby materially reducing the effect of competition.

Details and statistics.

Considering these matters more in detail, it will be possible, in some degree, to ascertain the cause of present conditions in reference to transportation in the United States by means of an analysis of statistics.

In 1889, our railroads carried 429,467,737 tons of freight. During the same year the quantity moved by water in American vessels as reported by the United States Census, amounted to 120,000,000 tons, excluding harbor and raft traffic. In 1906, the raitroads carried 1,610,099,829 tons, while the records show 177,519,758 tons carried by water in the same year.

Over 42 per cent of the water tonnage last named went over the great lakes, and nearly 37 per cent on the Atlantic and Gulf coasts and rivers.

More than half of this tonnage consisted of coal, iron ore and other crude minerals, while lumber and naval stores were next in importance as to quantity.

Third on the list, we find steel rails, pig iron, petroleum, cement, bricks, lime, etc.

Next in bulk, was the group of agricultural products, including grain, flour, fruits, vegetables, cotton and tobacco, these being the most important of all the commodities carried, so far as value is concerned.

The four groups just mentioned comprise 80 per cent of the traffic carried by American vessels. The remaining 20 per cent consists of package and miscellaneous freight which constitutes a large factor in the Atlantic and Gulf coast business by water carriers.

Comparing the above classification with that of the freight carried by railroads in 1906, we find practically the same proportions to obtain.

The Great Lakes.

In the year 1889, the domestic lake traffic was 25,267,000 net tons. In the year 1907, it was more than 80 million tons. Three fourths of the entire lake movement is easterly and southerly.

Iron ore and coal constitute the great bulk of the freight transported over the lakes. In 1907, we find 45 million net tons of iron ore were carried by lake lines, and over 21 million tons of coal, the latter moving westerly and representing about one quarter of the domestic lake traffic.

In 1907, the domestic movement of grain on the lakes was only 150 million bushels, and that of flour only 1,300,000 tons. These figures show a large falling off in recent years due to the decline in export trade.

It is interesting to note that only 5 per cent of the entire lake traffic is carried on to its destination by water after leaving the lakes.

Rivers and canals.

Up to the year 1855, the amount of freight carried by the canals in New York State was more than twice that transported by railroads crossing the state. In 1872, it was only one third, and at the present time, it is less than 3 per cent of that carried by the railroads adjacent thereto.

In 1880, the entire traffic of State and private canals in the United States was 16 million tons. In 1906, it had fallen off the about 6,600,000 tons.

One of the remarkable instances of declining business on waterways is seen in the Mississippi River system, which includes, n addition to the Mississippi itself, the Ohio River, the Missouri, thelllinois, Ouachita, Red and Yazoo Rivers, with all their tributaries, together with a number of other rivers of less importance. The State canals of Illinois and Ohio also are connected with this system, which, in former years, had a very large transportation business.

An index of the decline may be found in statistics of the river tonnage at St. Louis, which is a converging point for traffic of the upper Mississippi, and, to a certain extent, of the lower river also.

In 1890, shipments at St. Louis by steamboats and barges amounted to 601,860 tons. In 1903, they had fallen to 212,207 tons, and in 1904, to 82,565 tons. The following year there was a reduction to 80,575 tons, but in 1906, the shipments rose to 89,185 tons.

Rail shipments, on the contrary, increased in this district from 5 million tons in 1890, to 17 million tons in 1906.

Ohio river and tributaries.

This is, at present, the most important river system in the country as regards traffic.

In 1894, the total movement was 7,795,500 tons. Six years later, this had increased to 14,054,320 tons. In 1904, it had declined to 10,142,550 tons, but in 1905, it rose to 13,163,656 tons, falling again in 1906, to 11,427,784 tons.

Coal from the Pittsburg district and from the extensive fields in West Virginia constitutes an enormous tonnage overt his waterway, and it is due to this commodity that the traffic of the Ohio River system is of such magnitude at present and that there has not been a decided decrease in tonnage as in the case of other inland streams.

Equipment on waterways.

As to the equipment in use on waterways, we find statistics as follows.

The report of the Commissioner of Navigation gives, for the year 1870, the number of steam vessels as 3,524, sailing vessels, 17,534, barges, 1,530, and canal boats, 6,410.

In the year 1907, there were recorded 10,050 steam vessels, 10,866 sailing vessels and 3,264 barges.

More than half the steam vessels now registered are in capacity from 1,000 to 5,000 tons, and a quarter of the steam tonnage is in vessels of over 5,000 tons. Approximately two thirds of the sailing vessels run from 500 to 2,500 tons.

On the coasts and on the great lakes, vessels have greatly increased in size in recent years. On the inland rivers, there has been a considerable decline in steam vessel tonnage, while on the great lakes, sailing vesselsh ave almost disappeared. On the coasts, there are fewer sailing vessels than formerly but they have increased in size.

On western rivers, the large packet steamers have mostly gone out of use, while there has been an increase in the number of small gasoline boats and in the number of barges propelled by towing.

Canal boats are rapidly decreasing in number and in tonnage. The Census Reports for 1889 showed 5,544 canal boats in the United States, with a tonnage of 808,058 tons. In 1907 there were only 731 recorded, with an average tonnage of about 135 tons each.

On the Erie canal, there are now, according to the Bureau of Corporations, less than 450 boats available for transportation.

By the Census Reports, we find an increase in the number of self-propelled vessels in the United States from 5,603 in 1889 to 9,927 in 1906. Three fourths of these however, were small gasoline boats.

The tonnage capacity increase in this time is more marked, showing a rise of 137 per cent, from 1,710,000 tons in 1889, to 4,059,000 tons in 1906.

Among the larger vessels, we find the steamship " Creole „ employed in the Atlantic coasting trade, built in 1907. This is 407 feet long, 53 feet beam, 26 feet deep and registered at 6,387 gross tons. The engines are of the turbine type.

In the Pacific coasting trade, is the " President ", 417 feet long, 44 $^1/_2$ feet beam, 29 feet deep, with a capacity of 5,500 gross tons. Over four hundred passengers can be carried in addition to cargo space. The engines are of 5,000 indicated horse-power.

On the great lakes, there are freight and passenger steamers running regularly, 400 feet in length, and 97 feet wide over all.

One of the largest is the bulk freighter " Thomas F. Cole ", built in 1907. This is 605 feet long, 58 feet beam and 32 feet deep, registered at 7,268 gross tons, with an actual capacity for 12,000 tons of iron ore.

It is apparent that the cost of carriage is reduced generally in proportion to the size of vessels engaged in transportation. On nearly all our rivers and canals, the use of light draft boats is made necessary by reason of shallow and tortuous channels, thereby preventing economy of operation.

Reference has already been made to the wide differences in the physical characteristics of our inland waterways which necessitate corresponding diversities of equipment. This, of course, prevents the use of the same vessel for through transportation, and so transhipments are required, which increase considerably the cost of conveyance. Again, it is almost always necessary to transfer from vessels to rail and *vice-versâ*, since most freight consignments are either destined to points away from waterways or else originate at such points.

The following quotation is from the Report of the Commissioner of Corporations on Transportation by Water in the United States under date of July, 1909 :

It cannot be expected that any reasonable expenditure on our inland waterways will wholly remove these difficulties.

Transportation by water in the United States cannot be brought to the same degree of uniformity as on railroads, with a few standard types of vessels available for all classes of waterways. Water-borne traffic will continue to be carried, for the most part, in vessels adapted to particular classes of waterways and the special traffic of such waterways.

Through traffic moving from one waterway to another will require transshipment. Even on long inland hauls, transshipment will often be necessary. Moreover, traffic to and from many points not on a waterway must continue to be carried, at least for part of the distance, by rail, and transshipment will be necessary if such traffic is to move even in part by water.

Slow movement of traffic.

In many cases, the time required for transit by inland navigation lines is so great as to render competition with railroads out of the question. In the State of New York, for example, the time for through service by waterways is from ten to fifteen times as long as that taken by rail carriers.

More than this, the service by water is irregular and uncertain.

Canal breaks are of frequent occurence, and, on account of these, traffic is tied up for weeks at a time.

Waterway terminals.

Another element of disadvantage to waterway transportation in comparison to conveyance by rail is found in the difficulty of obtaining suitable terminals on account of extreme changes in water level which continually occur in times of freshets and droughts.

Marine insurance.

An important factor in the cost of water carriage is the insurance rate.

Railroad companies are compelled to assume the risk of loss of goods in transit as a part of operating expenses. Water carriers on the contrary, for the most part, are obliged to take out insurance on such property, and this must be added to the freight rate. Shippers therefore find it necessary to consider this item in order to determine the relative economy of water routes in comparison with rates by rail. In some cases however the shipper himself insures his goods in transit, and, again we find, in rare instances, no insurance whatever is carried.

On the Mississippi River, from Vicksburg to New Orleans, the freight rate on cotton is seventy five cents per bale, while cargo insurance is about twenty cents per bale in addition, making the insurance almost a third of the cost of the freight charge.

On the Red River, cargo insurance is 0·9 per cent of the value of the goods carried, while on Virginia and Maryland waterways, the insurance premium amounts to 3·1 per cent of the gross receipts of transportation companies.

It will be seen at once that these high rates, varying greatly also in different localities, operate strongly to the disadvantage of water carriers.

Government supervision.

A systematic, rigid inspection of vessels by the Government, and the strict requirements thereby imposed as to construction, operation and maintenance, are generally considered to affect water transportation unfavorably in comparison with railroads, although it is apparent that government control of railroads in the United States is steadily increasing in extent every year.

Taking into account then all the existing elements of disadvantage which have been referred to in connection with waterways, it is not surprising that they have so little effect in the way of competition with railways, and that they act for the most part, merely as feeders to railway lines.

Efforts have been made from time to time to make waterways an active part in our transportation system by means of government aid, and, at every session of our national congress, appropriations are passed for river and harbor improvements, generally on a liberal scale.

The total appropriations for inland river improvements alone, up to 1907, have been over 250 million dollars.

Government commissions have been appointed also to investigate the subject of waterway improvement and construction. In consequence of this, there is, at present in the United States, as in Europe, considerable popular agitation on the subject.

It is apparent however that if any efficient development is to be undertaken, it will be necessary to devise a comprehensive plan which must involve enormous expense, and it is altogether doubtful if the results would, by any means, justify the cost of such an enterprise.

At the present time, the State of New York is enlarging the Erie Canal to a twelve foot depth at an estimated cost of over 100 million dollars. A recent decision of the courts however as to liability for damages caused by this canal construction will bring the final cost far above this figure.

Up to the year 1909, the cost of the old Erie Canal, 352 miles long, has been approximately 57,600,000 dollars for a waterway which carries less than 3 per cent of the tonnage now taken by competing railways.

On the completion of the work of enlargement, there will be an additional burden of probably at least 125 million dollars expenditure imposed on the people of the state, notwithstanding the fact that grain rates on parallel railroad lines are less than four mills per ton-mile.

At 4 $^1/_2$ per cent, the interest on this total cost of construction amounts to 8,217,000 dollars yearly, to say nothing of the cost of maintenance and operation. For the ten years previous to 1908, there was an average movement of only 2 242,648 tons per annum on the entire canal. Official reports do not give the length of haul, but if a most liberal assumption in this regard is made in the same ratio to tonnage as on the railroads and canalized rivers adjacent, it will be seen at once what a disproportionalety heavy charge must be added to the actual cost of carriage based on operation and maintenance in order to make the canal self sustaining.

[385 .2]

REPORT N° 2

(all countries except Great Britain and America)

By C. COLSON,

GENERAL INSPECTOR OF BRIDGES AND ROADS,
STATE CONCILLOR OF FRANCE,

and Louis MARLIO,

ENGINEER OF BRIDGES AND ROADS

Purpose and plan of the report.

We do not think that the Congress, in placing on its agenda " the investigation of the influence of waterways considered as feeders and as competitors, on railways ", has had the intention of reopening, from a theoretical and speculative point of view, the question, so frequently discussed, of the competition between railways and waterways. It seemed to us that the interest of this work was to show, by a direct investigation of the facts, what the results of the competition or the co-operation of the two systems of carriage are in actual practice, and what the factors are which influence the division of the traffic between them.

Our enquiry was to extend to all countries, except the British Isles and the United States of America. We have sent lists of questions to all the railway administrations which, as far as we know, could have important relations with waterways.

We have received a large number of interesting answers. We must particularly mention the remarkable and extensive work supplied by the French Eastern Railway,

then also the answers sent by the French Northern, the French Western and the Orleans railways in France; by the Alsace-Lorraine State Railway, the Bavarian State Railway, the Baden State Railway, the Austrian State Railway and the Hungarian State Railway, In one case only were no answers supplied, namely by the administration of the Prussian State Railway which stated that it " regretted to have to refuse to answer question XIII "; we have done our best to supplement missing information.

It is after considering the answers received, the supplementary information which has been supplied to us by the administrations of railways and that which we were able to collect directly, that we are going to try to present a report on the question. The most important part of this report will consist in a review of the different factors which influence the distribution of the traffic between the two forms of conveyance, the chief being : the rates for carriage, the amount of the accessory charges, the length of the journey and the time it takes, the nature and value of the goods, the class and the habits of the customers, the situation of the places of origin and of destination, the direction of the traffic, whether import or export. All of these factors tend to produce a normal state of equilibrium which other influences may modify, for instance, the temporary influence of variations in the industrial activity.

According to the situation resulting from these different factors, the railway administrations are led to look upon waterways as allies at one time and as adversaries at another, and the difference in their opinions on this point in its turn reacts on the traffic conditions.

But in order clearly to understand the facts observed in the different countries, it is essential in the first place to know the administrative and financial regime of the railways and the waterways in each of them, and in the second, to know what are the essential characters of these latter from the technical and economic point of view. We will accordingly make a short examination of them, taking the chief countries, Russia, Germany, Austria, Hungary, France, Belgium, Holland, in succession. We shall add some statistical information which will make it possible to grasp the very varying importance, according to locality, of traffic by water as compared with traffic by rail.

This preliminary geographical review will enable us to deal more rapidly with the methodical consideration of the other aspects of the question. We will then examine the function of the different factors mentioned above, and make a comparative investigation regarding the net cost of carriage, by the two systems of conveyance, of traffic carried under conditions as nearly similar as possible.

FIRST PART.

Situation of the railways and waterways in the different States.

RUSSIA.

I. — Extent. — Geographical situation. — Cost of construction.

A. — *Railways.*

In 1905 the railways of Russia in Europe had a total length of 49,000 kilometres (30,450 miles), and had cost 9·5 milliards of francs (£380 millions), or 193,000 francs per kilometre (£12,424 per mile). This very low figure is due to the low price of land, to the flat nature of the greater part of the territory and to the large use of level crossings where roads are crossed. In spite of its extent, the Russian railway system is still a very large mesh one, owing to the vast size of the country; it has however hence been wisely avoided to locate railways near great rivers, which offer navigation sufficient facilities for coping with the traffic, such as the Volga and the lower Dnieper.

B. — *Waterways.*

The international navigation of Russia presents very special characters.

It is much favoured by the very gentle fall of the rivers. The central mass of Russia, which forms its culminating point, is in fact only 300 metres (984 feet) above sea-level.

The navigation is on the other hand impeded :

1° By insufficient connexion with sea navigation, as it ends in closed seas ;

2° By a very long duration of the period of frost, which makes it impossible to utilize the rivers during five months of the year.

There are few connections between the different basins. However, in order to save the traffic passing from one to the other, the expense of cartage over long distances, or even of porter's work (which has not entirely disappeared yet), there were built, before the development of the railways, navigable " systems " utilizing the tributaries of rivers or lakes, and connecting them by means of canals.

Two systems were begun between the Don and the Volga and remained uncompleted. There are two (the Catherine and the Duke of Wurtemberg systems) between the Volga and the White Sea; the first is abandoned. Finally, the Volga and the Neva are connected by the Vychnyolotschock and the Marie systems; the latter alone is of importance as it takes the traffic between the Volga and St. Petersburg.

The length of the waterways in Russia in Europe (Finland excluded) is 57,000 kilometres (35,420 miles), of which hardly 2,000 kilometres (1,242 miles) are artificial waterways.

The principle Russian river is the Volga, 3,300 kilometres (2,050 miles) of which are navigable, not counting its two chief tributaries the Oka and the Kama, which have 1,300 and 1,200 kilometres (807 and 745 miles) navigable respectively. The chief traffic on the Volga is on the 2,650 kilometres (1,646 miles) between Rybinsk and Astrakhan. The fall of the river varies on the different sections between 2 and 6 centimetres per kilometre (1·27 and 3·81 inches per mile). Its flow at low water increases from 300 to 3,300 cubic metres (10,600 to 116,500 cubic feet) per second, as we descend the river.

The depth of the channel at low water is 1·24 metres (4 ft. 1 in.) from Rybinsk to Nijni and 1·60 metres (5 ft. 3 in.) below Nijni; the current then only has a velocity of 25 to 70 centimetres (10 inches to 2 ft. 3 $^{9}/_{16}$ in.) per second. At high water (April-June) the current is stronger and sometimes even is as fast as 2 metres (6 ft. 6 $^{3}/_{4}$ in.) per second. But the river is then accessible for boats drawing 3 to 4 metres (10 to 13 feet) of water.

II. — Administrative regime.

A. — *Railways.*

At first there were companies with interest guaranteed, but now the chief system is that of operation by the State; in 1905 there were 31,000 kilometres (19,260 miles) operated by the State, as against 18,000 kilometres (11,185 miles) still operated by companies.

Before the Russo-Japanese war and the subsequent crisis, the operation of the Russian railways resulted in a profit representing 4 or 5 per cent on capital. The gross receipts amounted in 1905 to 1,744 million francs (£69,760,000), or 32,900 francs per kilometre (£2,118 per mile).

The rates of the private companies are subjected to strict control.

The State levies a tax of 15 per cent on the tickets of passengers exceeding 2 copecks (0·58*d.*), on luggage and on parcels; this brings in about 45 million francs (£1,800,000).

B. — *Waterways.*

All the Russian waterways are built, improved and maintained by the State.

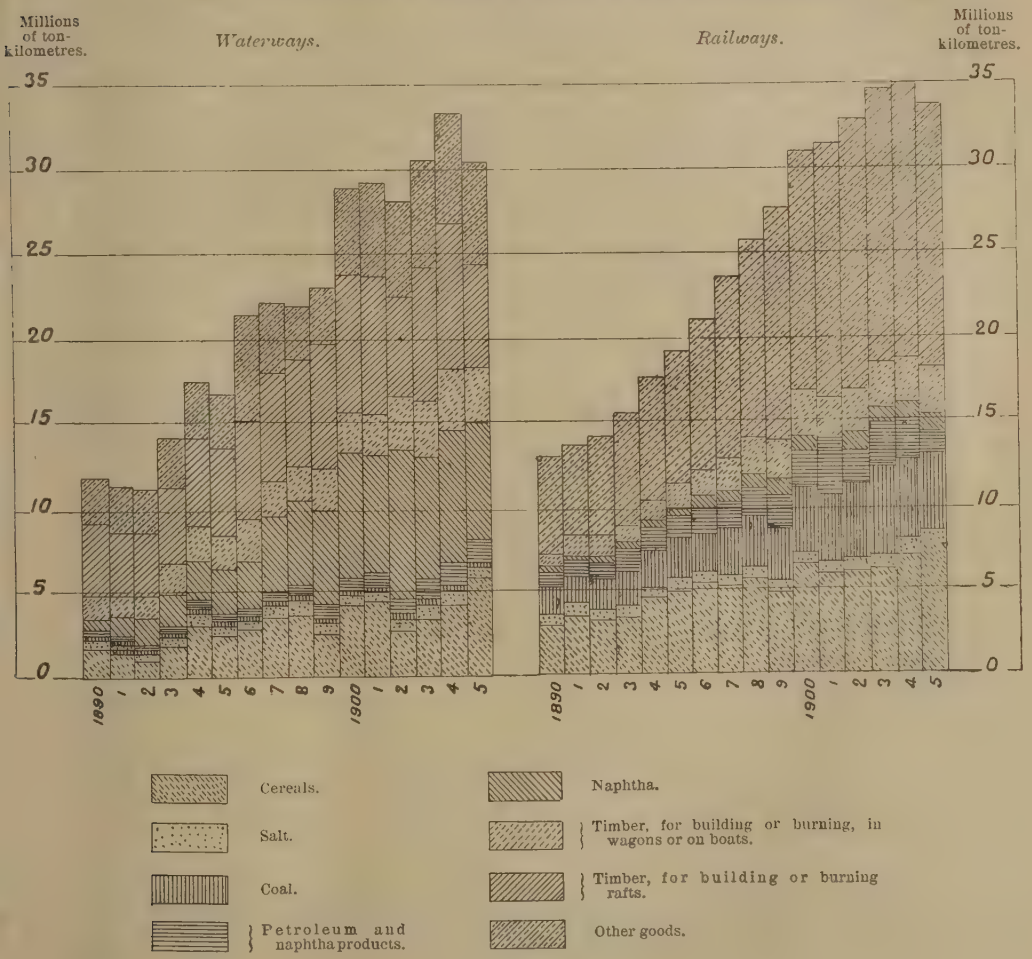
The annual expenditure incurred by the State for the purpose amounted in 1907 to 38 million francs (£1,520,000).

Ten years ago, the tolls which existed on the rivers and which brought in 2 or 3 million francs (£80,000 or £120,000) per year were abolished. A toll of $^{1}/_{2}$ per cent of the declared value of the cargo is still charged on the Ladoga canals, which form part of the Marie system. The amount yielded by these tolls is very small.

III. — Particulars of the traffic.

The diagram given below (fig. 1) represents, in millions of ton-kilometres, the amount of traffic carried on the railways and on the waterways of Russia in Europe as well as the composition of each kind of traffic classified under its principal headings.

Fig. 1. — **Goods traffic in Russia in Europe in the years 1890-1905.**



Very nearly the same amount of traffic is carried by the two different means of conveyance. This equality has been maintaining itself for twenty years, although there are marked fluctuations in the waterways traffic. These fluctuations are due to annual variations in the climatic conditions, which have a direct influence on the river navigation.

The progress of the traffic in the principal goods, in millions of ton-kilometres (in millions of English ton-miles), in the years 1885-1905, is shown in the table below.

ARTICLE.	Railways			Waterways		
	in 1885.	in 1905.	Increase per cent.	in 1885.	in 1905.	Increase per cent.
Cereals	2·97 (1·82)	7·88 (4·82)	165	1·92 (1·17)	6·30 (3·85)	228
Salt	0·70 (0·43)	0·70 (0·43)	...	0·44 (0·27)	0·53 (0·32)	20
Petroleum and naphtha.	0·61 (0·37)	2·10 (1·28)	244	0·53 (0·32)	8·75 (5·35)	1,551
Timber	0·70 (0·43)	2·62 (1·60)	274	4·29 (2.62)	10·15 (6·21)	137
Coal	1·14 (0 70)	4·72 (2·89)	314	0·09 (0·06)	0·17 (0·10)	89
Miscellaneous goods.	4·03 (2·46)	16·10 (9·85)	300	2·27 (1·39)	6·48 (3·96)	185
Total.	10·15 (6·21)	34·12 (20 87)	236	9·54 (5·83)	32·38 (19·79)	239

We may note the great increase in the naphtha traffic on waterways and the increase in the miscellaneous goods (manufactured articles and articles of value) traffic on railways.

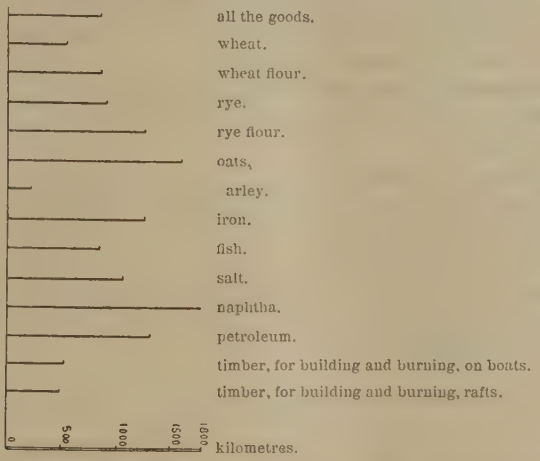
When, instead of dealing with the ton-kilometres, we compare the number of tons, we get the following figures :

	Railways.	*Waterways.*
In 1885	24,764,000 tons.	13,480,000 tons.
In 1895	42,771,000 —	23,878,000 —
In 1905	67,272,000 —	34,987,000 —

Although the tonnage has become more than doubled on railways, the mean distance the goods are carried is half less. It is estimated at 475 kilometres (295 miles), whereas on waterways it reaches the enormous figure of 950 kilometres

(590 miles). The adjoining diagram (fig. 2) shows the mean distance the chief classes of goods are carried on the waterways; from barley, which is only carried 200 kilometres (124 miles), to naphtha, which almost reaches 1,800 kilometres (1,120 miles).

Fig. 2. — **Mean distance goods are carried.**



The traffic on the Volga amounts to 16 million tons, or nearly half the total traffic on the Russian waterways; and with tributaries, to 20 million tons, or four sevenths of the total. The Volga traffic, which has tripled from 1885-1905, consists of one quarter of naphtha, one quarter of timber and one quarter of cereals. The main direction of the traffic is up river. Next to the Volga, the Dnieper must be mentioned, which has a traffic of more than 4 million tons, three fifths of which consist of timber carried either on boats, or more usually in the form of rafts. Finally the Marie system receives 2 million tons, 1·7 of which go to the Neva.

The following table shows the traffic at the most important ports in 1905:

Astrakhan	6.3	million tons.		Tsaritsyne.	1·5	million tons.	
St. Petersburg . . .	5·6	—	—	Saratov	1·5	—	—
Nijni-Novgorod . . .	2·7	—	—	Samara	1·5	—	—
Rybinsk	1 7	—	—				

These are all on the Volga, except St. Petersburg which is on the Neva.

IV. — Particulars of the rates.

The rates of the Russian railways are very low, particularly for long distances. The mean rate of 3·10 centimes per ton-kilometre (0·49*d.* per ton-mile) charged in 1905 is the lowest in the whole of Europe, in spite of the small importance of the

coal and mineral traffic, which represent generally the chief goods paying the lowest rates.

The freight charged on the Russian waterways varies extremely, according to their navigability.

The most favoured river is the Volga. It has a fleet of 1,700 steamships, 400 of which carry passengers; the others are used principally for naphtha. The boats attain large sizes and can carry up to 4,000 tons; we have even seen a naphtha boat of recent construction having a *capacity of 9,000 tons*. The greater part of the traffic is carried in barges carrying from 1,000 to 3,000 tons, hauled in lots which may reach 16,000 tons and which take thirty-three to thirty-six days to go up the Volga from Astrakhan to Rybinsk.

Freight is lower in spring than in autumn. It varies with the nature of the goods and may be estimated, on the average (1901-1905) at 0·4 centime the ton-kilometre (0·06*d*. per English ton-mile) in the case of naphtha, 0·5 centime (0·08*d*) in that of cereals and salt, and 0·7 centime (0·11*d*.) in that of iron.

The difference in the cost of carriage on the different Russian waterways may be estimated from the following table, which gives the mean freight charged on the chief ones for cereals in 1905 :

Volga	0·5 centime	per ton-kilometre	(0·08*d*.	per English ton-mile).
Duna	0·9	—	—	(0·14*d*.	—	—).
Marie system . . .	1·2 centimes	—	(0·19*d*.	—	—).
Dnieper	1·8	—	—	(0·28*d*.	—	—).
Don	2·7	—	—	(0·42*d*.	—	—).

V. — Mixed traffic.

Mixed traffic is particularly important in Russia. It has grown rapidly of late, as shown in the table below. The table on the following page shows, for 1905, the tonnage and nature of the chief goods transhipped from wagon to ship or vice versa, at the most important tranship ports.

—	1890.	1905.	Increase, per cent.
Number of tons transhipped from wagon to ship .	0·5 million.	1·4 million.	180
Number of tons transhipped from ship to wagon. .	2 millions.	4·5 millions.	125
Total. . .	2·5 millions.	5·9 millions.	170

A = Transhipment from wagon to ship (in thousands of tons).
B = — — ship to wagon (— —).

PORT.	Cereals.		Salt.		Naphtha.		Petroleum.		Coal.		Wood for burning.		Timber for building.		Transhipment from		*Total.* (A and B)
															railway to waterway	waterway to railway.	
	A	B	A	B	A	B	A	B	A	B	A	B	A	B	A	B	
Rybinsk (Volga)	1	349	...	24	...	300	...	34	...	...	...	...	...	11	1	718	719
Jaroslav (Volga)	1	83	...	21	...	514	...	37	...	...	1	...	...	54	2	709	711
Tsaritsyne (Volga)	21	3	...	14	...	114	...	178	19	...	...	4	1	295	41	608	649
Nijni-Novgorod (Volga)	11	85	...	19	...	375	...	45	...	...	1	...	9	18	21	542	563
Saratov (Volga)	13	8	...	42	...	159	...	129	4	...	...	...	3	44	20	382	402
Wladimirovka (Volga)	...	1	367	...	...	...	...	...	...	...	...	...	...	1	367	2	369
Kinechma (Volga)	...	47	...	11	...	214	...	3	...	...	...	4	...	32	...	311	311
Samara (Volga)	211	14	...	3	...	34	...	14	...	...	1	...	...	13	212	78	290
Alexandrovsk (Dnieper)	155	3	...	...	...	...	...	...	13	...	...	...	1	...	169	3	172
Kalatsch (Don)	37	8	3	...	...	...	9	...	...	...	...	...	113	...	162	8	170
Riazan (Oka)	1	1	...	1	...	101	...	...	...	...	...	16	...	32	1	151	152
Pokrovskaia (Volga)	134	3	...	...	...	...	...	...	...	...	...	6	...	13	134	22	156
Nijnedneprovsk (Dnieper)	...	...	55	...	...	...	...	...	18	...	...	4	1	65	74	69	143
Other ports	277	135	8	24	...	55	...	48	18	3	16	38	57	473	376	776	1,152
Total.	862	740	433	159	...	1,866	9	488	72	3	19	72	185	1,051	1,580	4,379	5,9

The total figure for 1905 represents 9 per cent of the total railway traffic. It is to be noted that it is really greater, for the data only apply to seven classes of goods, two of which (coal and wood for burning) only represent an insignificant tonnage.

Transhipments from wagon to ship are only important in the case of cereals (on the Dnieper and at certain Volga ports) and of salt, which the port of Wladimirovka (Volga) receives from Russia in Asia by a railway of which it forms the terminus.

Transhipments from ship to wagon are much more important; they include chiefly naphtha (nearly 2 million tons) transhipped at the middle and upper Volga ports (Jaroslav, Nijni, Saratov, Kinechma), for conveyance to Moscow and St. Petersburg, and building timber (1 million tons) transhipped at the ports of the lower Volga and Dnieper.

GERMANY.

I. — Extent. — Geographical situation. — Cost of construction.

A. — *Railways.*

At the end of 1907, the total length in operation was 56,000 kilometres (34,800 miles), which had cost 19·5 milliard francs (£780 millions), or about 350,000 francs per kilometre (£22,530 per mile). There are also nearly 10,000 kilometres (6,214 miles) of narrow-gauge lines, some of general interest, others purely local.

B. — *Waterways.*

The total length of the German waterways is 13,000 kilometres (8,078 miles), including 2,400 kilometres (1,491 miles) of canalized rivers and 2,400 kilometres (1,491 miles) of canals. The length really frequented by vessels does not exceed 10,000 kilometres (6,214 miles). Half of the system is accessible to boats drawing more than 1·50 metres (4 ft. 11 in.) of water.

It will be seen further on that four fifths of the traffic are concentrated on 1,800 kilometres (1,118 miles) on the rivers : the Rhine, the Elbe and the Oder. These three rivers have a very slight fall : the height of 100 metres (328 feet) is attained at distances from the sea of 621, 662 and 524 kilometres (386, 411 and 325 miles) respectively. As a rule, steam tugs are used. On the Elbe and the Oder the boats generally have a tonnage of 400 to 600 tons. On the Rhine, the usual figure is 1,000 tons; exceptionally it amounts to 2,000 or even 2,800 tons. The depth of water under ordinary low-water conditions in the case of the latter river is 3 metres (10 feet) up to Cologne, 2·50 metres (8 ft. 2 in.) up to St. Goar,

and 2 metres (6 ft. 6 3/4 in.) up to Mannheim. The Rhine and the Elbe do not wind much and consequently the boats do not go much round.

Navigation on the German rivers is suspended by the ice during a period which varies from one to three months according to season and to district. This unfavourable influence is particularly marked in eastern Prussia. On the other hand low water in summer frequently compels the boats to run without a full load.

The Rhine and the Elbe are free-running rivers. The same applies to the Oder, except as regards the upper section, 80 kilometres (50 miles) of which are canalized.

The most important canals in Germany are those belonging to the old Brandeburg system, which has Berlin as its centre, and the new Dortmund-Ems canal. These are accessible to boats of 400 and 600 tons.

The amount spent from 1816 to 1905 on inland navigation by the Prussian State, whose territory contains nearly all the German waterways, may be classified as follows :

Rhine, Weser, Elbe, Oder	180 million francs	(£7,200,000).
Canals and canalized rivers.	230 —	— (£9,200,000).

We do not include in this the important expenditure incurred, chiefly in the interests of agriculture, on the waterways of eastern Prussia, and on the canal from the North Sea to the Baltic, built for naval purposes.

Nor do these figures include the expenditure of the different districts on inland ports, which exceeds 200 million francs (£8,000,000). In this total the port of Berlin, which has but primitive installations, only figures with 2·5 million francs (£100,000).

II. — Administrative regime.

A. — *Railways.*

At the beginning of 1907, the German States themselves operated 52,000 kilometres (32,312 miles) out of the existing total of 56,000 kilometres (34,800 miles) of railways.

The operation of these railways is a considerable source of revenue to the State budgets. The net profit, calculated after deducting the sums, not included in the railway budgets, paid towards pensions, represented in 1907, as compared with the capital cost, more than 6 per cent in Prussia, 5 per cent in Saxony, nearly 4 per cent in Bavaria, and only 2·5 per cent in Wurtemberg.

The whole of the German standard-gauge lines showed in 1907 gross receipts of 3,428 million francs (£137,120,000) and expenses (pensions included) of 2,382 million francs (£95,280,000), or a net profit of 1,046 millions (£41,840,000), representing 5·35 per cent on the capital outlay.

No special tax was charged on railway traffic until recently. In 1906, a tax was

instituted, on behalf of the Empire, in the form of a stamp, on passenger tickets and way-bills; this yields 40 million francs (£1,600,000), obtained chiefly from passengers.

B. — *Waterways.*

The maintenance of the waterways costs the State each year about 20 million francs (£800,000).

Germany has long admitted that the State should see to the improvement and the maintenance of the natural waterways and that their use should be free. This freeness is guaranteed, in the case of all rivers, by the imperial constitution, and as regards the two chief, by international agreements as well.

Tolls have on the other hand been instituted, and then gradually raised, on the canals and the canalized rivers. These tolls always include several classes, so as to take into account the value of the goods. The tariffs differ on the different waterways. The following are the chief :

			Per ton-kilometre.	(Per English ton-mile.)
Dortmund-Ems canal	4 classes	0·4 to 0·06	centime	(0·06*d.* to 0·09*d.*)
Brandenburg waterways	4	— 0·2 to 0·5	—	(0·03*d.* to 0·08*d.*)
Canalized Main	2	— 0·4 to 0·8	—	(0·06*d.* to 0·13*d.*)
— Oder	4	— 0·2 to 0·8	—	(0·03*d.* to 0·13*d.*)
— Weser	3	— 0·3 to 0·9	—	(0·05*d.* to 0·15*d.*)

Except in the case of the Brandenburg waterways, these tolls do not even cover the cost of maintenance. The following is the financial situation of the waterways as regards the State :

—	Annual receipts 1905.	Annual cost of administration and maintenance. 1905.	In order to cover the annual expenses plus 3·5 per cent on the capital for interest and amortization, the receipts would require the following increase.
	Francs.	Francs.	Francs.
Free-running rivers	1,250,000 (£50,000)	13,265,000 (£530,600)	23,936,000 (£957,440)
Canals and canalized rivers	7,272,000 (£290,880)	6,856,000 (£274,240)	10,410,000 (£416,400)
Ports belonging to the State	5,760,000 (£230,470)	6,182,000 (£247,280)	7,176,000 (£287,040)
Total	14,282,000 (£571,280)	26,303,000 (£1,052,120)	41,522,000 (£1,660,880)

As regards the inland ports, both communal and private, the annual receipts (9,543,000 francs [£381,720]) cover the annual cost of administration and mainte-

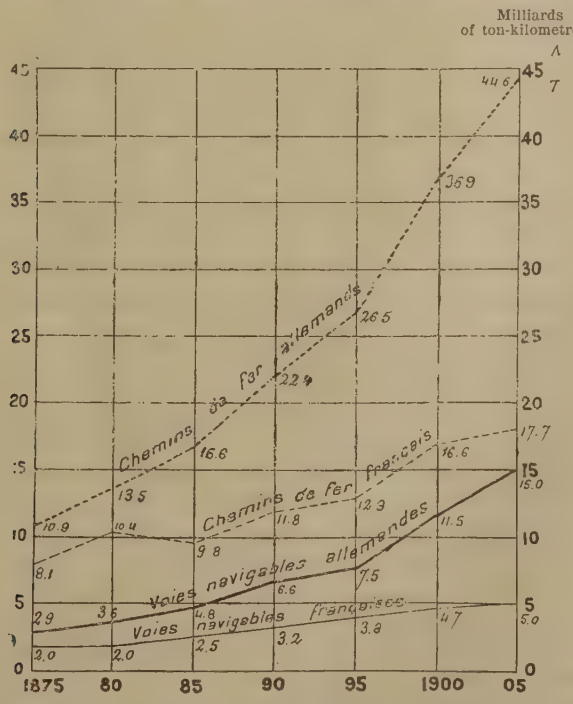
nance (6,800,000 francs [£272,000]) and give a net profit representing about 2·5 per cent on the capital outlay.

In a recent bill providing for large extensions and improvements in the inland waterways, the Prussian parliament introduced a clause to enable tolls to be levied on free-running rivers, in order to cover the cost of maintenance and that of new works intended to facilitate navigation. This clause being invalid under the imperial constitution, the imperial government brought forward, on 13 March 1909, a proposal to amend the constitution on this point.

III. — Particulars of the traffic.

The diagram given below (fig. 3), taken from the work published every five years by Mr. Sympher, compares the progress of the traffic on railways and on waterways, in France and in Germany, from 1875 to 1905 :

Fig. 3. — **Goods traffic on railways and waterways.**



Explanation of French terms : Chemins de fer allemands = German Railways. — Chemins de fer français = French railways. — Voies navigables allemandes = German waterways. Voies navigables françaises = French waterways.

The proportion of the inland waterway traffic, as compared with the total traffic, nas increased from 21 to 25 per cent in Germany during this period.

The mean distance slow-freight goods are carried on railways dropped from 164 to 114 kilometres (102 to 71 miles) during the period 1885-1905. On the waterways, on the other hand, it increased from 280 to 290 kilometres (174 to 180 miles)(1) during the period 1875-1905. We show in the table below how according to Mr. Sympher the traffic on the German waterways is distributed.

BASINS.	Length in kilometres (in miles).	Number of ton-kilometres (English ton-miles) per year.	Mean traffic per kilometre (per mile) per year, in tons.
Rhine	2,480 (1,541)	6,986,000,000 (4,270,000,000)	2,817,000
Elbe	1,093 (699)	3,649,000,000 (2,232,000,000)	3,339,000
Oder	1,327 (825)	1,660,000,000 (1,015,000,000)	1,251,000
Brandenburg canals	1,243 (772)	1,590,000,000 (972,000,000)	1,279,000
Ems	332 (206)	239,000,000 (146,000,000)	720,000
Vistula	353 (219)	204,000,000 (125,000,000)	578,000
Weser	644 (400)	184,000,000 (113,000,000)	286,000
Miscellaneous	1,978 (1,229)	298,000,000 (182,000,000)	151,000
Total and mean	9,450 (5,872)	14,810,000,000 (9,057,000,000)	1,567,000

The corresponding figures for the three chief rivers (without their tributaries) are:

BASINS.	Length in kilometres (in miles).	Number of ton kilometres (English ton-miles) per year.	Mean traffic per kilometre (per mile) per year, in tons.
Rhine (from Kehl to the Dutch frontier)	570 (354)	6,493,000,000 (3,971,000,000)	11,400,000
Elbe (from the Austrian frontier to Hamburg)	621 (386)	3,584,000,000 (2,192,000,000)	5,770,000
Oder (from Kosel to Stettin)	641 (398)	1,433,000,000 (876,000,000)	2,240,000
Total and mean	1,832 (1,138)	11,510,000,000 (7,039,000,000)	6,290,000

(1) According to Mr. Sympher, and taking into consideration the foreign mileage of goods imported or exported.

If we leave out of consideration in the case of the Rhine the 130-kilometre (81-mile) section between Mannheim and Kehl, where the traffic at each point decreases as we ascend, from 3 to 1 million tons, we find on the 440 kilometres (273 miles) included between the Dutch frontier (Emmerich) and Mannheim, four ninths of the total traffic of the German waterways; the mean traffic per kilometre per year exceeds 15 million tons.

The traffic of the chief ports in 1905, in thousands of tons, is given in the table below.

CHIEF PORTS.		Number of tons		TOTAL.
		received.	dispatched.	
Rhine basin	Duisburg group	7,930	11,532	19,462
	Mannheim	4,309	987	5,296
	Ludwigshafen	1,306	515	1,821
	Frankfort on the Main	1,311	269	1,580
Elbe basin	Hamburg	3,113	4,740	7,853
	Magdeburg	1,301	767	2,008
Oder basin	Stettin	793	1,678	2,471
	Kosel	181	1,382	1,513
Brandenburg waterways	Berlin-Charlottenburg	9,414	700	10,114

IV. — Particulars of the rates.

A. — *Railway.*

The general and special tariffs include the station charges, to which the charge for loading and unloading have to be added in the case of goods not sent in full truck-loads, of which there however but few. The rate charged is in principle proportionate to the distance. The initial rates, expressed in centimes per ton and per kilometre (in pence per English ton and per mile), are as follows for truck-loads of 5 tons (tariffs A 1, and A 2) or of 10 tons (tariffs B, I, II, and III), slow freight :

General tariff.		Special tariff for certain goods.			
A_1	B	A_2	I	II	III
8·375	7·5	6·25	5·625	4·375	3·25
(1·315)	(1·177)	(0·981)	(0·883)	(0·687)	(0·510)

The initial rate of special tariff III becomes reduced to 2·75 (0·432*d.*) beyond

100 kilometres (62 miles); the others do not decrease when the distance increases.

More important are the exceptional tariffs which apply to two thirds of the slow-freight traffic of Germany. These tariffs often have fixed initial rates; the rate per kilometre however decreases in some cases at great distances. The most reduced tariffs are the *sea-port tariffs*, which are intended to favour German export trade, or else the import of goods which Germany does not produce.

B. — *Waterways.*

Freight is very variable according to the technical, geographical and economical value of the different waterways. It varies on each river with the time and the nature of the goods; the variation can attain 50 per cent in the first case and 20 per cent in the second. Here are some instances of the average freight charged on the chief articles carried :

WATERWAYS.	Article.	Journey.	Distance in kilometres.	Freight		*Remarks.*
				total in francs.	per ton-kilometre, in centimes (per English ton-mile, in pence).	
Rhine	Cereals	Rotterdam-Mannheim.	543 (337)	3·80 (3*s.* 1·1*d.*)	0·66 (0·104)	Average 1901-1905.
	Coal	Duisburg-Mannheim.	326 (203)	3·25 (2*s.* 7·7*d.*)	0·92 (0·144)	Freight artificially increased by 20 to 30 per cent since the formation of the Kohlen-Kontor.
	Coal	Duisburg-Rotterdam.	217 (135)	1·30 (1*s.* 0.7*d.*)	0·60 (0·94)	Average 1896-1905.
	Half manufactured	Ludwigshafen-Rotterdam.	550 (342)	2·00 (1*s.* 7·5*d.*)	0·35 (0·055)	Return freight.
Dortmund - Ems canal	Coal	Dortmund to Emden.	270 (168)	2·06 (1*s.* 8·1*d.*)	0·75 (0·118)	Not counting tolls.
Weser	Cereals	Bremen-Hameln.	244 (152)	5·37 (4*s.* 4·4*d.*)	2·25 (0·353)	
	Sugar	Hameln-Bremen.	244 (152)	2·18 (1*s.* 9·3*d.*)	0·90 (0·141)	Return freight.
Elbe	Coal	Aussig-Magdeburg.	366 (227)	3·30 (2*s.* 8·2*d.*)	0·9 (0·141)	The freight on the Elbe has since 1904 a tendency to go up, in consequence of a combine between the chief shipping companies.
	Cereals	Hamburg-Dresden.	581 (361)	6·91 (5*s.* 7·4*d.*)	1·21 (0·190)	
Oder	Coal	Breslau-Berlin.	567 (352)	6·92 (5*s.* 7·5*d.*)	1·22 (0·192)	Average 1897-1906.

If we consider, not the total value, but the variation in the freight, we find that during the last thirty years, this has fallen on the average : 40 to 60 per cent on the Rhine, 30 to 50 per cent on the Weser and 30 per cent on the Brandendurg canals.

During the same period the rates on the Prussian railways have on the average been reduced by 16 per cent and on the whole of the German railways by 19 per cent.

V. — Mixed traffic.

We give particulars below of the tonnage transhipped at the chief German ports from wagon to boat and from boat to wagon. The figures refer to 1905, unless otherwise stated.

WATERWAYS.	PORT.	Number of tons transhipped		Total per port.
		from wagon to boat.	from boat to wagon.	
Rhine	Lauterburg	...	375,000	375,000
	Karlsruhe	90,000	405,000	495,000
	Strasburg	227,000	470,000	697,000
	Mannheim	370,000	2,053,000	2,423,000
	Rheinau	...	1,270,000	1,270,000
	Frankfort	212,000	461,000	673,000
	Gustavsburg	15,000	853,000	868,000
	Cologne (1908)	164,000	266,000	430,000
	Duisburg-Ruhrort-Hochfeld	10,283,000	3,905,000	14,188,000
	Others ports	62,000	538,000	600,000
	Totals.	11,423,000	10,596,000	22,019,000
Elbe	Dresden (1906)	115,000	285,000	400,000
	Riesa (1906)	47,000	484,000	531,000
	Schönebeck	445,000	78,000	523,000
	Magdeburg	458,000	661,000	1,119,000
	Harburg	153,000	251,000	404,000
	Other ports	137,000	333,000	470,000
	Totals.	1,355,000	2,092,000	3,447,000
Weser	Cassel, Hameln, Minden	173,000	112,000	285,000
Dortmund-Ems Canal	Munster, Dortmund, etc.	93,000	281,000	374,000
Oder	Kosel	1,388,000	176,000	1,564,000
	Breslau	629,000	143,000	772,000
	Other ports	110,000	38,000	148,000
	Totals.	2,127,000	357,000	2,484,000
Danube	Passau-Ratisbon	53,000	243,000	296,000

*

We can summarize these results in the following table :

WATERWAYS.	Number of tons transhipped		Total.
	from wagon to boat.	from boat to wagon.	
Rhine	11,423,000	10,596,000	22,019,000
Elbe	1,355,000	2,092,000	3,447,000
Weser	173,000	112,000	285,000
Dortmund-Ems Canal	93,000	281,000	374,000
Oder	2,127,000	357,000	2,484,000
Danube	53,000	243,000	296,000
General total. . .	15,224,000	13,681,000	28,905,000

The particulars we have just given are necessarily incomplete. We were unable to obtain the figures of some ports, particularly of the two great ports of Düsseldorf and Ludwigshafen.

Hence it does not seem doubtful that the tonnage of the transhipments exceeds thirty million tons. This figure does not however correspond to the actual tonnage of the mixed traffic, as certain goods were transhipped twice. This is the case with coal from Westphalia, first shipped at one of the Ruhrort ports and transhipped a second time at Gustavsburg, Frankfort, Mannheim, Rheinau, Ludwigshafen, Strasburg, Lauterburg and Karlsruhe. The tonnage of these goods which are twice transhipped may be estimated at 4·5 or 5 million tons.

Taking it altogether, of the 66 millions tons carried on German waterways, 4·5 to 5 millions tons have used a railway twice, and about 21 millions tons have used it once only.

In these transhipment figures, the chief part is taken by the Rhine (more than 22 million tons), and on that river, by the group of Ruhrort port (14 million tons). The latter traffic consists, as far as arrivals are concerned, of ore and cereals going to Westphalia, and, as far as departures are concerned, of Ruhr coal (9,500,000 tons) going to Holland (2,500,000 tons), to Belgium (1 million tons) and to ports on the Upper Rhine and their Hinterland (6 million tons).

The tonnage transhipped represents about 7 per cent of the total 400 million tons carried on the railways in 1905.

AUSTRIA.

A. — *Railways.*

The total length of railways in operation in 1906 in Austria amounted to 18,800 kilometres (11,680 miles), which had cost 5,800 million francs (£232 millions) (a little less than half of this had been spent by companies), or about 360,000 francs per kilometre (£23,174 per mile).

At that time, the State operated 13,000 kilometres (8,078 miles). But the State since then has taken over several companies, namely the Kaiser Ferdinands Nordbahn (1907), the Bohemian Northern Railway (1908), the Austro-Hungarian State Railway Company and the Austrian North Western Railway (1909). Except the Austrian Southern Railway, there are still in existence only companies of very little importance.

The goods traffic on the whole system amounted to 10,200 million ton-kilometres (6,238 millions English ton-miles).

The total receipts amounted to nearly 700 million francs (£28 millions), the expenses to 440 millions (£17,600), and the net profit to nearly 260 millions (£10,400,000), representing 4·4 per cent on the capital outlay.

The tariffs contain the same conditions and are of the same type as those of the German railways. Those of the companies are uniformized. Special agreements are authorized, provided that any resulting advantages are granted to every consignor accepting the conditions.

The Austrian State levies a tax of 12 per cent on the passenger fares, which yielded 17·5 million francs (£700,000) in 1905.

In addition there are 2,665 kilometres (1,656 miles) of railways of Austria and Hungary jointly, the chief item being the Austrian Southern Railway. This system has cost 1,400 million francs (£56 millions) and has a total length of 2,200 kilometres (1,367 miles), of which 1,530 kilometres (950 miles) are on Austrian territory. Its goods traffic amounted in 1906 to 2,280 million ton-kilometres (1,394 million English ton-miles). The net profit amounted to 60 million francs (£2,400,000), representing 4·2 per cent on the capital outlay.

B. — *Waterways.*

In Austria there are 2,600 kilometres (1,616 miles) of waterways, all rivers; 1,300 kilometres (808 miles) of them can take steamships.

The only important waterways are the Danube, 365 kilometres (227 miles) the Elbe, 109 kilometres (68 miles), and its tributary the Moldau, 242 kilometres (150 miles).

The Upper Danube is but a poor waterway; it has a current of 1·80 metres (5 ft. 11 in. per second, all the more objectionable as the bulk of the traffic is up river. The Moldau current entirely stops up-river traffic. The Elbe on the other hand has only a small fall and a comparatively weak current.

The waterways are maintained and managed by the Austrian State, which spends about 8 million francs (£320,000) per year for the purpose and levies no tolls.

A large project, involving an expenditure of about 800 million (£32 millions) has been brought forward for building canals connecting the Danube with the Oder and with the Elbe, and for canalizing the Moldau. Its execution is problematical.

In the table below we give statistical data about the traffic on three chief Austrian waterways in 1905 :

WATERWAY.	Total tonnage (in millions of tons).	Down-river tonnage (in millions of tons).	Up-river tonnage (in millions of tons).	Tonnage, steamships (in millions of tons).	Ton-kilometres, millions (English ton-miles, millions).	Mean distances carried (in kilometres [in miles]).
Danube	1·8	0·9	0·9	1·3	260 (159)	139 (86)
Elbe	3·9	0·6	3·3	3·5	152 (93)	83 (24)
Moldau	1·2	0·09	1·1	0·8	42 (26)	34 (21)
Total, Austrian waterways	7·2	...	...	5·5	486 (297)	67 (42)

The predominating part played by steamships has to be noted. The Moldau traffic is diminishing during the last few years. The chief item in the Danube traffic is the up-river carriage of Rumanian and Hungarian corn. The Elbe traffic consists nearly wholly of lignite carried from Aussig to Germany.

The mean distances given only correspond to the journey on Austrian territory. If that in other countries were taken into consideration, they would have to be considerably increased, particularly as regards the Elbe and the Danube down-river traffic.

The freight on the Danube and the Elbe varies between 0·6 to 1·4 centimes (0·09*d.* to 0·22*d.* per English ton-mile); it averages 1·1 centimes per ton-kilometre (0·17*d.* per English ton-mile). It is lower on the Elbe than on the Danube. The mixed traffic plays a very important part on the Elbe at the ports of Aussig (coal) and of Tetschen (miscellaneous).

HUNGARY.

A. — *Railways.*

The Hungarian Railway system is altogether 17,000 kilometres (10,564 miles) in length; 7,300 kilometres (4,536 miles) of it are local railways operated by the administration of the State Railway, on account of the owners. This does not include the comparatively-small part of the Austro-Hungarian system, which is on Hungarian territory. The State operates the whole of railways, except about 1,500 kilometres (932 miles).

The standard-gauge main-line and local system cost 3,450 million francs (£138 millions) (900 millions [£36 millions] of which were spent by companies), or 330,000 francs per kilometre (£21,243 per mile).

The goods traffic amounted in 1906 to 5 milliard ton-kilometres (3·058 milliard English ton-miles).

The gross receipts were 365 millions (£14,600,000), the working expenses 221 millions (£8,840,000) and the net profit 144 millions (£5,760,000); this represents 4·2 per cent on the capital outlay.

The Hungarian State levies a tax of 20 per cent on passenger fares, of 7 per cent on quick-freight receipts and of 5 per cent on slow-freight receipts. This tax yielded 25 million francs (£1 million) in 1905.

B. — *Waterways.*

The Hungarian waterway system is altogether 3,100 kilometres (1,926 miles) in length. It consists of rivers, with the sole exception of the Franz canal. This canal is 238 kilometres (148 miles) long; a concession for it was granded in 1870, for seventy-five years, to a company which levies tolls varying from 0·015 to 0·05 franc per ton-kilometre (0·24*d.* to 0·78*d.* per English ton-mile).

The rest of the system is managed by the State which spends about 7 million francs (£280,000) per year on it and levies no tolls for its use.

The most important sections of the river systems are, firstly the Danube, 1,033 kilometres (642 miles); then its tributaries, the Tisza, 461 kilometres (286 miles), the Save, 604 kilometres (375 miles) and the Drave, 229 kilometres (142 miles).

Three quarters of the Danube traffic is up-river traffic (cereals).

The traffic on the whole Hungarian system amounts to nearly 4 million tons and represents about 1,500 million ton-kilometres (917,400,000 English ton-miles).

FRANCE.

I. — Extent. — Geographical situation. — Cost of construction.

A. — *Railways.*

The total length of the general railway system of France in operation on 31 December 1907 was 40,050 kilometres (24,886 miles), which had cost 17,862 million francs (£714,480,000), or 466,000 francs per kilometre (£28,710 per mile).

The cost of construction was made up as follows (before the repurchase of the French Western) :

Expenditure by the State (including repurchases)	5,532 million francs		(£221,280,000).
Expenditure by the companies (not including expenditure made by them on lines subsequently repurchased)	12,089	—	— (£483,560,000).
Expenditure by districts	241	—	— (£9,640,000).
Total.	17,862 million francs		(£714,480,000).

In this we do not include local railways and tramways which also carry slow-freight traffic; at the end or 1907 there were 12,600 kilometres (7,829 miles) in operation, which had cost 840 million francs (£33,600,000).

B. — *Waterways.*

The system of French waterways actually used for navigation proper had the following length in 1907 :

Free-running steams and rivers	3,400 kilomètres		(2,113 miles).
Canalized streams aud rivers	3,600	—	(2,237 —).
Canals	4,900	—	(3,045 —).
Total.	11,900 kilomètres		(7,395 miles).

Of this total, 4,800 kilometres (2,483 miles) are accessible to Flemish canal-boats carrying 300 tons. The canalized Seine, from Rouen to Corbeil (277 kilometres [172 miles]), has a channel 3·50 metres (11 ft. 6 in.) deep and takes vessels carrying 4,100 tons.

Only two rivers (the Rhone and the Seine) are of serious importance as regards water-borne traffic. The first has against it the rapid current caused by its considerable fall, for it has a height of 100 metres (328 feet) at 215 kilometres (134 miles) from the sea; the second its tortuous course, so that it is nearly twice as long as the crow flies.

The expenditure on French waterways (construction of canals, improvement of

streams and rivers), made nearly entirely by the State, may be estimated at 1,800 million francs (£72 millions), 1,600 millions (£64 millions) of which have been spent on works since 1821.

This expenditure is distributed very irregularly over the different waterways. On the principal lines of the system (from Paris to the north, to Belgium and the east, and from the north to the east), having a length of 1,400 kilometres (870 miles) and carrying half the total traffic, the expenditure on building and on improvements hardly exceeds 250,000 francs per kilometre (£16,093 per mile). The most recently constructed routes are the most expensive.

Canal from the Aisne to the Marne	413,000 francs per kilometre	(£26,585 per mile).
— — Marne to the Saone	570,000 —	—	(£36,692 —).
Seine improvements	450,000 —	—	(£28,968 —).
Canal from the Oise to the Aisne	725,000 —	—	(£46,670 —).

II. — Administrative régime.

A. — *Railways.*

Most of the French railways were built by private companies. The State gave them subventions, and these subventions represent nearly the total cost of most of the new lines with little traffic which are built now-a-days. In addition, the State guarantees the companies a minimum revenue; the sums paid under this head are however but advances, repayable when the net receipts exceed the guaranteed revenue. There is in France a State railway system which included 2,800 kilometres (1,740 miles) at the end of 1907 and to which the act for the State purchase of the French Western Railway (13 July 1908) added 5,800 kilometres (3,604 miles).

As against the subventions received from the State, the railways bestow on it several receipts and economies which for the financial year 1907 may be estimated as follows :

Duties on traffic	Passengers (12 per cent of the rates)	74 millions	(£2,960,000).
	Receipt stamps	43 —	(£1,720,000).
Common-law duties on the stock issued by the companies	Stamp	11 —	(£440,000).
	Transfer duties	17 —	(£680,000).
	Tax on revenue	30 —	(£1,200,000).
Economies in the public services resulting from the reductions in the rates or from free conveyance specified in the tariffs	Posts and telegraphs	63 —	(£2,520,000).
	Soldiers and sailors	37 —	(£1,480,000).
	Customs and indirect contributions	3 —	(£120,000).
Net profit of the State system		13 —	(£520,000).
	Total	291 millions	(£11,640,000).

This figure is considerably higher than the total annual charges imposed on the State for the railways during the same period, namely :

Interest on borrowed capital expended on works carried out by the State and on subventions paid in capital	129 millions (£5,160,000).
Annuities paid to the companies for capital supplied by them or for exchanges of lines	79 — (£3,160,000).
Total. . .	226 millions (£9,040,000).

We leave out of consideration the guaranteed interest which is of the nature of an advance; in 1907 (an exceptionally-favourable year), 37 million francs (£1,480,000) were received by the State from three companies, either as repayments or as share of profits, while it paid 16 million francs (£640,000) to four other companies.

The receipts earned by the general railway system of France amounted in 1907 to 1,702 million francs (£68,080,000), as against working expenses of 956 million francs (£38,240,000); the net profit was 746 million (£29,840,000), representing 4·18 per cent on the capital outlay.

B. — *Waterways.*

It is the State which constructs and maintains the waterways.

Those for which concessions had been granted were repurchased in the middle of the 19 th. century, except 250 kilometres (155 miles) which included :

1° The canal from the Sambre to the Oise;
2° The canals of the city of Paris;
3° Sections of no importance.

The cost of maintenance and management amounted to about 19 million francs (£760,000); the land receipts and the taxes yielded about 3 million francs (£120,000).

Since 1880 shipping pays nothing for the use of the waterways; neither on the open line, nor at the locks, nor at the public ports.

An act of 3 July 1900 has authorized the chamber of commerce of Saint-Dizier to levy tolls on the canal from the Marne to the Saone, for constructing which it had borrowed 5 million francs (£200,000). The tolls charged amount to 0·6 centime per ton-kilometre (0·09*d.* per English ton-mile), for any class of goods. The same system will be applied to the Northern canal, on whose construction the chamber of commerce of Douai is going to spend 30 million francs (£1,200,000). The tolls may amount to 1·2 centimes per ton-kilometre (0·18*d.* per English ton-mile) in the case of articles of value.

The Marseilles chamber of commerce, which is going to defray the greatest

part of the cost of the canal from Marseilles to the Rhone, will pay interest on the loan necessary by a toll levied not on the boats, but on the whole traffic of the seaport.

III. — Particulars of the traffic.

We give below (fig. 4) a diagram showing the progress of the traffic on the railways and the waterways.

After remaining practically constant during thirty years (1850-1880), the total traffic on the waterways increased gradually and very regularly from 2 milliard to 5·3 milliard ton-kilometres (1,223 to 3,241 millions English ton-miles). The increase in the first place began in the average distance goods were carried, which grew in five years (1881-1886) from 110 to 133 kilometres (68 to 83 miles), as a result of the unification of the type of locks. During the last twenty years, the increase has chiefly been in the number of tons shipped.

The average length of journey was 154 kilometres (96 miles) in 1907. This figure is slightly lower than the average on railways which is estimated at about 165 kilometres (103 miles); the figure of 127 kilometres (79 miles), given in the statistics, is in fact under the truth, for the statistics are compiled for each railway separately, so that each ton travelling on two railways is counted as two units.

The traffic on the waterways is distributed very irregularly. Geographically considered, the north and north eastern part of France, forming one fifth of the whole country, includes four fifths of the water-borne traffic.

Of the three classes of waterways, we can leave out the traffic on the free-running rivers, which is quite insignificant except in the case of the Rhone, and even there it only amounts to 90 million ton-kilometres (55 millions English ton-miles). The rest of the traffic is divided between the canalized rivers (two fifths) and the canals (three fifths).

The mean tonnage per kilometre of waterway is practically equal in the two latter classes, amounting to about 600,000 tons. This figure is largely exceeded on the Seine (2·5 million tons), on the main line from the north to Paris (3·5 million tons), on that from the north to the east (1·8 million tons), and *a fortiori* on the common trunk of the two latter, the Saint-Quentin canal (5 million tons).

The principal inland port is Paris; the traffic there consisted of 10·5 million tons, made up as follows:

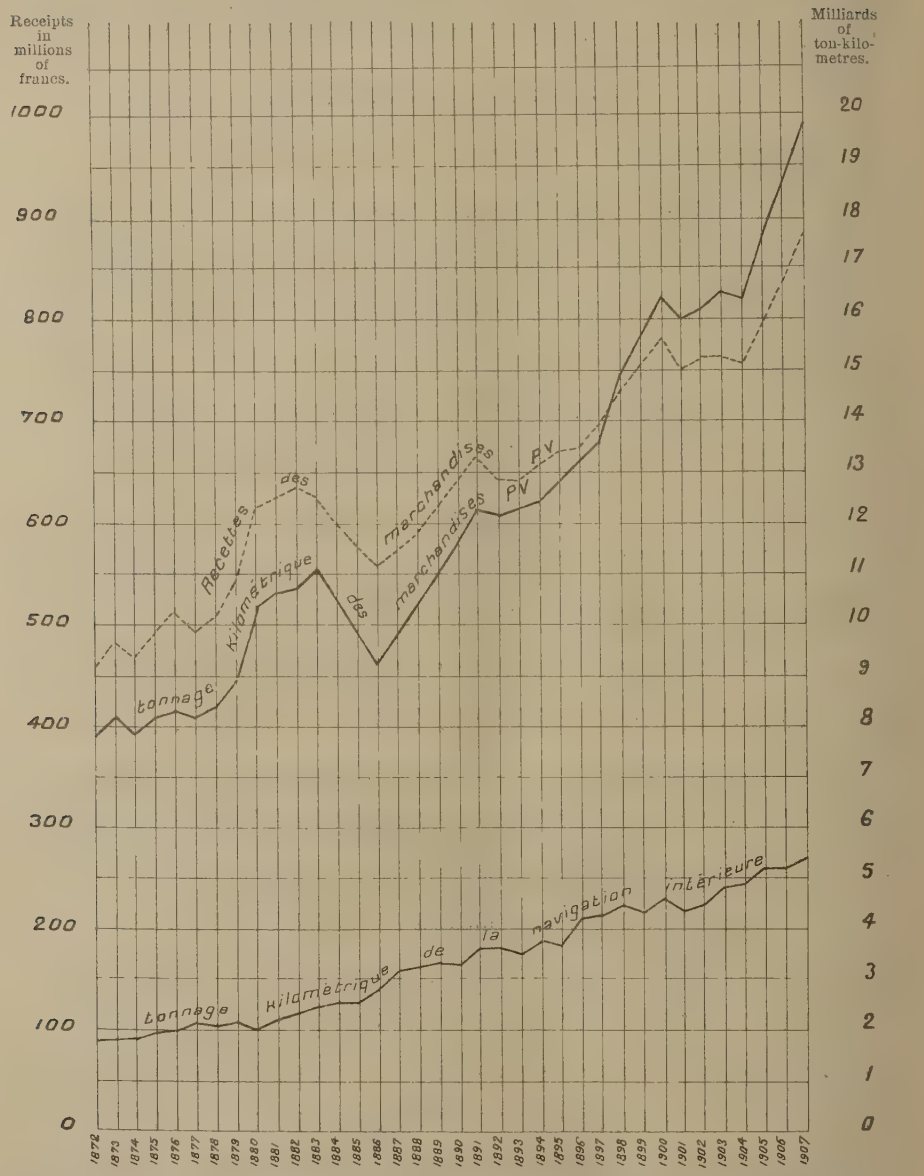
received	2·5 million tons,	transit	1·4 million tons,
despatched	6·3 — —,	home traffic	0·3 — —.

Next come:

Rouen	2·4 million tons.	Albon.	1·1 million tons.
Dunkirk	1·2 — —	Villeneuve St. Georges . .	1·1 — —

Thus there are five ports each with a traffic exceeding 1 million tons; next three

Fig. 4. — **Diagram showing the slow-freight traffic and receipts of the main railroads and the traffic on the waterways of France.**



Explanation of French terms : Recettes des marchandises = Slow-freight receipts. — Tonnage kilométrique des marchandises = Slow-freight traffic, ton-kilometres. — Tonnage kilométrique de la navigation intérieure = Water-borne traffic, ton-kilometres.

are ten ports with a traffic of from 0·5 to 1·0 million tons, and then one hundred ports with a traffic of from 0·1 to 0·5 million tons.

IV. — Particulars of the rates.

It is impossible to give any particulars of the rates charged on French railways; the system of rating is too complicated. We will only recall that on the main lines fixed rates are still numerous, and that differential rates are extensively applied. The scales applied generally include, apart from a constant and rather small amount for terminal charges, a rate calculated according to distance, the rate decreasing as the distance increases; in the case of heavy goods the decrease is quick and the final rate is often very low (2 centimes [0·32*d*. per mile], 1 centime [0·16*d*. per mile] or even less, for every additional kilometre).

We would also mention that in the matter of tariffs, the initiative lies with the railways and the right of confirmation with the minister of public works, who decides after an enquiry, with the advice of the consultative committee of the railways.

The predominating system in the case of French shipping is that of small undertakings. Two fifths of the boats belong to owners who have but one boat and run it themselves. Undertakings of any size (twenty boats or more) only account for one tenth of the total number. The solitary owners are those who carry the large traffic; their freight nearly always consists of one single consignment. The consignor and the consignee attend to the handling of the goods. The competition of the solitary owners determines the rates and reduces them to near the net cost, leaving but little remuneration to the owner; these rates vary on the different lines.

As the normal freight on the lines which are in good condition (north or east), in the direction of the chief traffic and for long distances, we may give 1·2 to 1·5 centimes (0·19*d*. to 0·24*d*. per English ton-mile). In the opposite direction, the return freight, if freight is scarce (leaving Paris or Nancy), sometimes falls to 0·7 or 0·8 centimes (0·11*d*. to 0·13*d*. per English ton-mile).

On the Seine, the normal freight is 1·4 centimes (0·22*d*. per English ton-mile) up river (direction of the heaviest traffic) and 1 centime (0·16*d*.) down river.

On the central and southern canals the freight amounts to 2 centimes (0·32*d*.); on the Rhone, to 3 or 5 centimes (0·47*d*. or 0·78*d*. per English ton-mile).

Finally the large shipping companies, who try to obtain the valuable-article traffic, fix their freight according to the railway rates, granting reductions varying from 10 to 30 per cent, according to case.

During the last thirty years freights have fallen at least 20 per cent in France.

V. — Mixed traffic.

Such traffic is very rare in France.

The total number of tons transhipped from wagon to boat or from boat to wagon

amounted to about 800,000 tons (or 0·5 per cent of the total railway tonnage), about half of which was transhipped at the port of Roanne.

The transhipping traffic at that port in 1907 was made up as follows :

From wagon to boat .	208,000 tons including	145,800 tons of pyrites going from Saint-Bel to Paris. 42,200 tons of mineral waters going from Saint-Galmier, etc., to Paris. 14,600 tons of coal, etc.
From boat to wagon .	128,500 tons including	36,000 tons of sand and stone from Nemours. 21,000 tons of coal. 15,600 tons of iron and cast iron.
Total. . .	336,500 tons.	

We may also mention the ports of Monluçon and Ivry on the Orleans system, and those of Varangéville and Giraucourt on the Eastern system.

BELGIUM.

I. — Extent. — Cost of construction.

A. — *Railways.*

At the end of 1907, the total length of the general railway system operated in Belgium was 4,600 kilometres (2,858 miles), which had cost 2,660 million francs (£106,400,000), or 570,000 francs per kilometre (£36,692 per mile), not including the suburban railways, 3,000 kilometres (1,864 miles) of which were being worked.

B. — *Waterways.*

The waterways are altogether 2,000 kilometres (1,242 miles) in length, made up of : free-running rivers, 500 kilometres (310 miles); canalized rivers, 550 kilometres (342 miles); canals, 950 kilometres (590 miles).

A large part of the system was built at the beginning of the 19th century. The amount spent on construction from 1831 to 1907 amounted to about 400 million francs (£16 millions).

II. — Administrative regime.

The State owns and operates more than 4,000 kilometres (2,485 miles) of the 4,600 kilometres (2,858 miles) forming the main railroad system of Belgium.

In 1907, the gross receipts (taxes not included) of the main railroad system were 299 million francs (£11,960,000), and the working expenses 200 million francs (£8 millions). The net profit, 99 million francs (£3,960,000), represents 3·72 per

cent on the capital outlay, and this approximately covers the financial charges. If we only consider the State system, the net receipts (82 million francs [£3,280,000]) are little lower than the financial charges.

Except in the case of a very few provincial and communal canals, and canals for which concessions have been given (Blaton to Ath, Brussels to the Rupel), the waterways are maintained by the State. The toll principle is applied generally in Belgium to the waterways, except on the tidal Scheldt and its tributaries, the middle Meuse and some secondary waterways. The tolls charged, reduced and unified in 1886 after long discussions, amount normally to 0·16 centime per ton-kilometre (0·025*d.* per English ton-mile) on canalized rivers and to 0·5 centime (0·08*d.*) on the canals.

These tolls yielded 2,200,000 francs (£88,000) in 1907, thus practically paying for the expenditure incurred by the State on maintenance and working in the same year (2,300,000 francs [£92,000]).

The receipts and expenses of the Belgian State for the waterways are given, in millions of francs, in the following table :

PERIOD.	Cost of maintenance.	Cost of construction.	Receipts.	Difference between the receipts and the cost of maintenance.	
				plus.	minus.
From 1831 to 1840 . .	4·5 (£180,000)	9·4 (£376,000)	13·8 (£552,000)	9 3 (£372,000)	...
From 1841 to 1850 . .	12·6 (£504,000)	17·7 (£708,000)	28·8 (£1,152,000)	16·2 (£648,000)	...
From 1851 to 1860 . .	14·7 (£588,000)	37·1 (£1,424,000)	29·7 (£1,188,000)	15 (£600,000)	...
From 1861 to 1870 . .	14·3 (£572,000)	62·2 (£2,488,000)	21·5 (£860,000)	7·2 (£288,000)	...
From 1871 to 1880 . .	22·9 (£916,000)	90·2 (£3,608,000)	16·7 (£668,000)	...	4·2 (£168,000)
From 1881 to 1890 . .	23 (£920,000)	70·3 (£2,812,000)	14·8 (£592,000)	...	8·2 (£328,000)
From 1891 to 1900 . .	20·8 (£832,000)	46·2 (£4,848,000)	20 (£800,000)	0·8 (£32,000)	...
From 1831 to 1900 . .	112·8 (£4,512,000)	333·1 (£13,324,000)	145·3 (£5,812,000)	36·1 (£1,444,000)	...
	445·9 (£17,837,000)				
In 1907	2·3 (£92,000)	10·5 (£420,000)	2·2 (£88,000)	...	0·1 (£4,000)

III. — Particulars of the traffic.

The statistics do not give the mileage on the Belgian railways.

The carriage of the goods classified as " grosses marchandises ", which very nearly correspond to what we call slow-freight in France, supplies 57 per cent of the receipts, corresponding to 71 million tons, an increase of 29 per cent as compared with 1900 (55 million tons).

On the waterways the traffic increased to 52 million tons. The average distance each ton was carried (in Belgium) was only 23 kilometres (14 miles). The number of ton-kilometres amounted in 1907 to 1,200 millions (734 millions English ton-miles), an increase of 35 per cent as compared with the figure for 1900 (894 millions [547 millions English ton-miles]).

One fourth of this total is however composed of canal-boat traffic on the estuary of the Scheldt, below Antwerp, which can hardly be considered an inland waterway.

Next to the Scheldt, the busiest lines are the canalized Meuse, the canal joining the Meuse and the Scheldt, the Sambre, the canal from Maestricht to Bois-le-Duc and the upper Scheldt, which together give about 500 million ton-kilometres (306 millions English ton-miles).

The steam traffic (steam barges or steam tugs) is important; it amounts to 450 million ton-kilometres (275 millions English ton-miles), half being on the estuary of the Scheldt.

IV. — Particulars of the rates.

The railway tariffs are in the form of scales of differential rates. Taking them altogether, they are appreciably lower than those applied as a rule in Germany and France. They differ but little from those applied on the French Northern Railway.

The freights on the Belgian waterways vary much (0·5 to 4 centimes per ton-kilometre [0·08*d.* to 0.64*d.* per English ton-mile]) according to the dimensions of the boats they can accommodate, the season, and the length of journey.

There is practically no mixed traffic.

HOLLAND.

A. — *Railways.*

The railway system was 3,400 kilometres (2,113 miles) long at the end of 1907. The capital outlay is unknown to us; it represents 861,000 francs per kilometre (£55,425 per mile) in the case of the Dutch Railway Company.

The greater part of the railway system has been built by the State, the rest by companies. The usual system of operation is that of leasing, with division of gross receipts. In 1906 the receipts amounted to 122 million francs (£4,880,000), the expenses to 89 million francs (£3,560,000) and the net profit to 33 million francs (£1,320,000). The companies can fix their own rates; the State only sees that the legal maximum is not exceeded. These rates are moreover low, owing to the competition of the network of canals extending over the whole country. The goods traffic amounted to 1,250 million ton-kilometres (764 millions English ton-miles).

The waterways have a total length of 5,200 kilometres (3,231 miles), made up of 2,000 kilometres (1,242 miles) of rivers and 3,200 kilometres (1,988 miles) of canals.

The rivers are maintained and managed by the State.

The canals have three different origins :

1° The canals specially built for purposes of navigation, which are of but little importance if we leave the sea canals (North Sea canal, Amsterdam to Ymuiden, and Terneuzen) out of consideration;

2° The old draining canals, sometimes very wide and rather deep, on many of which there is a busy steam traffic. To this class belong the Amstel and the Spaarne, which have a depth varying between 2·20 and 3·70 metres (7 ft. 3 in. to 12 ft. 2 in.), and a width varying between 40 and 250 metres (131 to 804 feet);

3° The canals excavated more recently in the provinces of Friesland, Groningen, Overyssel, and Drenthe, for carrying peat.

One tenth of the Dutch canal system belongs to private owners, two tenths to the State, three tenths to the provinces, four tenths to the communes or corporations.

The State did not contribute to the capital outlay till after 1840.

From 1850 to 1900, it has apent 300 million francs (£12 millions) on the improvement and maintenance of waterways; nearly half of this sum was more especially for the benefit of sea traffic. The rivers are free; on the canals varying tolls (0·25 to 1 centime per ton-kilometre [0·04*d.* to 0·16*d.* par English ton-mile]) are charged, generally levied when passing locks or bridges; but the yield of these tolls does not cover the cost of maintenance of the canals. Tolls have recently been abolished on State canals, but they still exist on most of the others.

SECOND PART.

Factors which influence the distribution of the traffic between railways and waterways.

We must in the first place make an important remark : the competition of waterways, even in a country where they are much developed, can never affect more than a fraction of the railway traffic.

Passenger and parcels traffic avoids waterways nearly entirely, as does the greater part of the broken-load slow-freight traffic. On the other hand, it is just because the railway does work which no other means of communication can do, that modern States desire to have railways in all parts of their territory, both those accessible to shipping and those which are not. It follows from this that for geographical reasons the waterway system is generally much less extensive and above all much less regularly distributed than the railway system.

In short, railways can compete with waterways everywhere and for every class of traffic (1), whereas the inverse is not true. It follows that, in the question which we are considering, railway statistics cannot be utilized except with the greatest caution, because they include, not only the elements of a service comparable with a waterway service, but also elements of a totally different nature.

I. — Cost of carriage.

The cost of carriage is generally the chief factor in questions of competition. Unless there are special reasons to the contrary, the consignor gives the preference to the cheapest way.

We shall see that the most disputed articles are heavy goods consigned in large lots. On many of the waterways, they form nearly the whole traffic. Consequently if we wish to compare railway rates with waterway rates, it is necessary, in order to obtain a proper comparison, to take the corresponding rates for consignments consisting of train-loads, or at least of a set of truck-loads, the handling being at the cost of the customer.

The system of rating is of great importance as regards the division of the traffic. We shall see that waterways will obtain a share of the traffic which will be the greater the longer the distance the goods are carried. The railway tariffs which compete most advantageously against waterways will accordingly be those which give the lowest rate for the longest distance, that is to say those in which the rate

(1) The Volga excepted, along which there is as yet no railway.

per kilometre decreases rapidly as the distance increases. They make it above all very difficult to have mixed carriage, when the destination itself is not on a waterway; that part of the journey which must then be necessarily effected on the railway will in such a case become much more costly, as it will be rated as a *separate* journey paying a price based on the high initial rates, and not as *additional kilometres* on which a very low rate is paid. It is for this reason that the German system of tariffs, in which prices are proportional to the distance (equal mileage rates), is more favourable to the waterways than the French and the Belgian systems, which include scales of differential rates. The mean height of the rates depend moreover to a large extent on the sacrifices the different States make on behalf of their railways, or on the other hand, on the burdens they impose on them. The same applies to the waterway rates. The first part of this paper shows (except perhaps in Holland) that the railways are seriously handicapped in this respect as compared with the waterways. Goods carried on the railway have to pay : 1° the maintenance of the track ; 2° the capital charges, and moreover in many cases earn for the operator (State or company) a profit which may be considerable (in Prussia for instance) ; goods carried on railways are nearly always freed from the two latter items and only pay a small fraction of the first, when they are not freed altogether.

Apart from tolls, the factor which has the greatest influence on the cost of carriage on waterways, is the *true value of the way from a technical point of view*.

a) One of the disadvantages of a waterway is that it presents, as compared with a railway, a *longer journey*, for it has to go round obstacles which a railway can go through, and it has generally to follow the bottom of valleys. This lengthening does not exceed 17 per cent in the case of the two large German rivers, from Rotterdam to Mannheim or from Hamburg to the Austrian frontier. It is greater in France and attains :

From Paris (La Tournelle)	to Nancy	17 per cent.
	to Dijon	26 —
	to Lyons	25 —
	to Dunkerque	48 —
	to Valenciennes	26 —
	to Rouen	78 —

b) A small fall is favourable to navigation. We can easily classify the chief continental rivers from this point of view by stating that a height of 100 metres (328 feet) above sea-level is attained at the following distances from the mouth :

Rhone	215 kilometres	(134 miles).	Rhine	621 kilometres	(386 miles).
Loire	398 —	(247 —).	Elbe	662 —	(411 —).
Oder	524 —	(326 —).	Danube	1,725 —	(1,072 —).
Seine	556 —	(345 —).	Volga	2,490 —	(1,547 —).

c) On canals and canalized rivers, the fall shows itself by the number of locks, which are a cause of delay. Now every loss of time involves an increase in the freight; for if the distance the boat travels during a year is reduced, it is necessary that every kilometre covered should yield a greater fraction of the remuneration of the crew and of the interest on the capital outlay. The number of locks varies greatly with the topographical situation; the proposed canal from the Rhine to Hanover will only have 8 locks on a length of 310 kilometres (193 miles), while the Marne to Rhine canal has 177 locks for the same length.

If there are many locks, it is not possible to give them large dimensions without excessive capital outlay. They then can hold only one barge (this is the case on French canals), and consequently haulage by tugs becomes impossible.

d) The small size of the locks moreover makes it impossible to use large boats. Now, other things being equal, the freight varies inversely as the tonnage. Large boats realize important economies, for the cost of traction and of staff increases at a much lower rate than the load. We find great differences in this respect, between the Berry 80-ton barges and the great 9,000-ton petroleum boats on the Volga.

e) The navigation is interrupted by being stopped. Voluntary stoppages, for facilitating the execution of works, are becoming rarer and rarer. But ice has always to be taken into consideration; this stops navigation a month in the east of France and the west of Germany, two months in the east of Germany and five months in Russia.

Finally in Germany, low water has to be taken into consideration; its duration and extent are very variable in different years, and often results in high freights; sometimes the traffic is even stopped altogether. Thus the Rhine at Strasburg was navigable 160 days in 1904 and 268 days in 1905, so that the traffic at that port amounted to 415,000 and 807,000 tons respectively. The interruption of the navigation, making it necessary to cover the fixed charges of the boats while effecting a smaller number of voyages per year, naturally leads to a general rise in freights to which one has to add the inconvenience suffered by the customers.

f) The freight largely depends on the organization of the traction. The old motive powers, men, horses, donkeys, are being replaced more and more by mechanical motors which are faster, more regular and particularly advantageous when traction can be applied to entire trains.

If we summarize all these considerations, we must conclude that a good canal is worth more than a poor river, but that it is very inferior to a good river. The freight may come down to 1·5 centimes (0·24*d*. per English ton-mile), to 1 centime (0·16*d*.) and even to a little less on a good canal; but only on a great river, with important traffic, where trains of boats carrying several thousands of tons are hauled, is it possible to obtain those freights of 0·4 to 0·05 centime (0·06*d*. to 0·08*d*. per English ton-mile), which the economists admire on the Rhine and the Volga.

We have spoken of freight as if it were a well-defined quantity. Actually it is however only an average, for freight is subjected to many fluctuations during the year :

1° Freight varies, for the same article, on the same river, with the height of the water, for if this is low, the boat may only be able to take a reduced cargo. This cause of variation is particularly appreciable in Germany and Russia; the rise it causes in freights attains and even exceeds 50 per cent at certain periods. Thus for instance the freight on cereals, from Antwerp to Strasburg, which is usually 5·50 francs (4*s*. 5·6*d*. per English ton., rose to 8·75 francs (7*s*. 1·3*d*.) during the month of January.

2° Freight is largely influenced also by the law of supply and demand. The freight on coal, for instance, always rises during the winter, at the time when the need for coal most makes itself felt; it is on the contrary very low in summer.

During August 1907, the freight from Charleroi was 6·75 francs (5*s*. 5·8*d*. per English ton to Rheims, 7·25 francs (5*s*. 10·7*d*.) to Nancy and 7·70 francs (6*s*. 3·1*d*.) to Epinal; in March of the same year it had been 7·25 francs 5*s*. 10·7*d*.) to Rheims, 8·25 francs (6*s*. 8·5*d*.) to Nancy and 8·75 francs (7*s*. 1·13*d*.) to Epinal. The same fluctuations were observed in case of coal brought from the north to Paris; the freight was 6·25 francs (5*s*. 1*d*. in January, October, November and December 1907, and only 5 francs (4*s*. 8*d*.) in the summer months of the same year.

Sometimes the variations are even greater : in 1906, the Seine boats were unable to cope with the English coal which had arrived at Rouen, and the freight from Rouen to Paris suddenly rose from 3 to 5 francs (2*s*. 5·3*d*. to 4*s*. 0·8*d*. per English ton).

There is, however, a whole class of water-borne traffic the charges for which are nearly fixed and which are not immediately affected by the law of supply and demand. This is the carriage of articles of value effected by large shipping companies running regular services. We shall see further on that these companies hardly ever compete against each other, and chiefly strive to take away from the railways traffic in articles which can bear high freights, by offering a definite reduction on the railway rates, determined so as to allow for the lesser facilities offered to its customers.

We stated at the beginning of this chapter that in most cases a better rate is a sufficient reason in the choice of one of two competing systems of carriage. Nevertheless the railway has as compared with its competitor important advantages such as quickness, regularity and safety. It is generally admitted that the traffic does not become diverted until the difference of rate, in favour of the waterways, attains 15 or 20 per cent. But that is only an average figure, and we shall be able to mention several cases where competition exists, owing to peculiar conditions, although the difference in the rates is far removed from the 20 per cent which it has been desired to fix as an absolute rule.

II. — Terminal charges.

On the railways, the amount of the terminal charged is fixed in the official and permanent tariffs. In France, 30 centimes per ton (2·93*d*. per English ton) must be allowed for the loading and also for the unloading of truck-loads. The German tariffs are a little higher, but the parties interested or forwarding agents nearly always attend to the handling.

On the waterways, the loading costs about 20 to 75 centimes (2·93*d*. to 7·32*d*. per English ton) and the unloading 50 centimes to 1 franc (4·88*d*. to 9·76*d*.).

If one wishes to compare direct carriage by rail with mixed carriage (rail and water), the cost of transhipment has also to be taken into consideration. We give below, as an instance, the amount charged at different tranship ports which are well equipped.

	From wagon to boat.	*From boat to wagon.*
Saxon State Railway (Dresden or Riesa) .	0·50 to 0·70 franc per ton (0·88*d*. to 0·83*d*. per English ton).	0·90 to 1·00 franc per ton (8·78*d*. to 9·76*d*. per English ton).
Baden — — (cereals)	1·00 franc per ton (9·76*d*. per English ton).	0·80 franc per ton (7·80*d*. per English ton) (in bulk). 1·10 franc per ton (10·73*d*. per English ton) (in sacks).
— — — (coals)	0·90 franc per ton (8·78*d*. per English ton).	0·90 franc per ton (8·78*d*. per English ton).
Bavarian State Railway (cereals at Würzburg)	0·60 franc per ton (5·85*d*. per English ton).	0·75 franc per ton (7·32*d*. per English ton).

As a rule, the rail or water carriage has to be supplemented by cartage from the port or station to the manufactory. Cartage, the cost of which increases with the distance, is a heavy charge on the manufacturer. It often restrains him from taking full advantage of boom times, for his supply of horses is limited. In order to eliminate these two disadvantages and to benefit moreover by the advantages of automatic unloading methods, manufacturers have sidings in connection with the railway. This adaptability of iron roads, which enables them to run to each works and even to each part of a works, forms also one of the points in which railways are much superior to waterways.

The French railways have not failed to see the advantage they could draw from this adaptability. The French Northern Railway, in particular, has much facilitated the construction of private sidings, by advancing manufacturers the capital necessary, by doing away with the sidings charges in many cases and by building at its own expense, in the suburbs of large cities, principal lines from which a series of sidings branch. As a result, the French Northern had 1,100 private sidings in 1908, as against 605 stations for the general slow-freight services.

The influence of such sidings in enabling cartage between station and works to be

eliminated, is shown by the following table, for 1906, referring to the Charleville district :

—	Total tonnage dispatched and received.	Tonnage dispatched and received by water.		Tonnage dispatched and received by rail.	
		Total.	Per cent.	Total.	Per cent.
Works with sidings	533,600	75,500	14	458,100	86
Works without sidings . . .	171,400	72,300	42	99,100	58

This advantage of the railways disappears if the establishment concerned is located on the banks of the waterways, so that either method of conveyance can be used without cartage. This is generally the case with the works in the districts of Nancy and of the upper Marne, and this explains that although they have sidings in connection with the railway, the waterway receives a considerable part of their traffic (1906).

Connected works in the district of	Total tonnage dispatched and received.	Tonnage dispatched and received by water		Tonnage dispatched and received by rail.	
		Total.	Per cent.	Total.	Per cent.
Nancy	4,308,400	1,348,400	31	2,965,000	69
The upper Marne	788,300	259,200	33	529,000	67

The influence of railway sidings also makes itself felt in Holland, where the competition of railways is much more acute in the small towns, which often are not served by the railway, than in large towns (Amsterdam, Rotterdam, etc.), where all the works are connected with the railway, and where, on the contrary, the needs of the town traffic tend to close certain canals.

III. — Length of the journey to be effected.

Is the competition of waterways independent of the distance?

In answering this question, we have to remember that the cost of carriage by water, as well as that of carriage by rail, includes a part which is independent of the distance and dependent on the loss of time during loading and unloading; its relative importance decreases as the distance increases. This loss of time is especially important in the case of shipping, as these operations are generally slow and immobilize the staff as well as the boat.

Thus for instance, at one and the same time, the following freights were quoted at Hamburg for the conveyance of 100 kilograms of cereals to the following ports :

Magdeburg	(293	kilom.)	[182	miles].	0·81	franc	or 2·7	centimes	per ton-kilom.	(0·42*d.*	per	Engl.	ton-miles).
Dresden	(566	—	) [352	—	]. 0·90	—	or 1·6	—	—	(0·25*d.*	—	—	).
Aussig	(654	—	) [406	—	]. 1·06	—	or 1·4	—	—	(0·22*d.*	—	—	).

The rate for the freight per unit of distance thus diminishes very appreciably as the distance increases, and the total saving which can then be effected by water carriage becomes sufficiently large to outweigh all its disadvantages.

Thus normally, the competition of the waterways makes itself more strongly felt at long distances.

It is in Germany that this phenomenon is most clearly marked. Water carriage, on the large rivers without locks or on canals with but few locks, is quick; the terminal charges accordingly represent a correspondingly greater part of the total freight. On the other hand, the normal or special rates of the railways are in most cases strictly proportional to the distance. Thus Mr. Sympher has calculated that a consignment would benefit by utilizing the new canal from the Rhine to Hanover as soon as it has to travel more than 40 kilometres (25 miles), if the starting point and the arrival point are on the banks of the canal. If one of these two points is not immediately on the canal, mixed carriage would not become advantageous until the distance exceeded 70 kilometres (43 miles), and if two transhipments were necessary, only when it exceeded 160 kilometres (100 miles).

The preceding consideration explains how it is that the average distance consignments are carried is generally shorter on railways than on waterways. The difference as a rule exceeds the extra length, referred to above, of the waterway between any two given points; whence we may conclude that it influences the traffic more the further distant the localities concerned are from each other.

Thus in Russia, the average distance is 475 kilometres (295 miles) on railways and 950 kilometres (590 miles) on waterways; in Germany, the average distance is 114 kilometres (71 miles) on railways and 290 kilometres (180 miles) on waterways.

In France, the phenomenon is less clearly marked, for two reasons : firstly the freight on our waterways is not as low as in Germany and in Russia; on the other hand, the railway tariffs include largely-differential rates. Certains rates (minerals) are lower than even our lowest freights. The average distance on the waterways is 154 kilometres (96 miles), practically equal to that on railways, if we correct for the fact that the statistics count each ton travelling on two railway systems as two tons.

If, however, we examine certain routes more closely, we still find a certain preference of waterway traffic for long distances; the comparison for the chief articles forming the traffic on the Eastern system is given below.

—	Average distance. in kilometres (in miles)	
	by railway.	by waterway.
Salt to other stations on the Eastern system	266 (165)	428 (266)
Salt to stations on the Northern system	348 (216)	477 (296)
Cereals	70 (43)	157 (98)
Minerals	14 (8·6)	281 (175)

The following table, compiled by the French Eastern Railway, shows, for both methods of conveyance, the average distance coal is carried between Nancy and the different coal-fields supplying that district. This table shows that the distances are greater on the waterways than on the railways; but the difference is not appreciably greater than that resulting from the tortuous nature of the waterways.

Coal and coke. — Year 1907.

From the districts named to Nancy.	Sarre.			Ruhr.			Liége.		
	Railways.		Waterways. — Total traffic.	Railways.		Waterways. — Total traffic.	Railways.		Waterways. — Total traffic.
	Total traffic.	Traffic for which the waterways compete.		Total traffic.	Traffic for which the waterways compete.		Total traffic.	Traffic for which the waterways compete.	
Tonnage	569,000	461,800	170,000	80,300	76,900	53,300	11,100	9,200	40,300
Mean distance in kilometres (in miles)	137 (85)	165 (103)	152 (94)	429 (267)	428 (266)	799 (496)	294 (183)	289 (180)	457 (284)

From the districts named to Nancy.	Charleroi.			Nord.			Pas-de-Calais.		
	Railways.		Waterways. — Total traffic.	Railways.		Waterways. — Total traffic.	Railways.		Waterways. — Total traffic.
	Total traffic.	Traffic for which the waterways compete.		Total traffic.	Traffic for which the waterways compete.		Total traffic.	Traffic for which the waterways compete.	
Tonnage	22,700	18,400	133,100	191,000	172,400	137,700	313,600	299,900	183,300
Mean distance in kilometres (in miles)	307 (191)	299 (186)	521 (324)	341 (212)	338 (210)	477 (296)	391 (243)	385 (239)	504 (313)

Although usually favoured for longer distances, it must not be thought that waterways cannot be suited to medium or even short distances. But then the point which decides the question is not the comparison of the *cost of carriage* proper, but the difference in the *terminal charges*. In this case, the waterway can only compete when it connects two concerns both located on its banks. Such is the case, mentioned by the Orleans Railway, for lime carried from La Guerche to Bourges or Vierzon. The Midi Railway mentions the traffic between the Montech paper-mill and Dieupentale station, which really forms a sort of water-cartage for goods intended for the railway.

However, even in the case of establishments on the banks of waterways, it can happen that the railway still competes for shorter distances, thanks to a perfect organization of the private sidings and of the unloading installations. This is what happens in the case of minerals from the Nancy district, which are carried in large quantities 560,000 tons in 1906) on the railways, over the very short distance (14 kilometres [8·3 miles]) between the mines of Landres, Pompey, Marbache, and the blastfurnaces at Jarville, Maxéville, Pont-à-Mousson, Pont-Saint-Vincent, although there are waterways at all these points. The preference given to the railway is explained by the need of bringing the goods to the boat or taking them from the boat on the very banks of the canal, while a wagon can fetch it from any point on the mine or in the works.

IV. — Time required for the journey.

The advantage of the railway is generally very marked, particularly if we consider not the legal time the railway may take, but its ordinary time, which is appreciably shorter.

On the French Northern Railway, the legal time as a rule does not exceed three or four days, unless the goods are rated under a special tariff allowing an extra five or ten days. As a matter of fact, the traffic department of that railway makes every effort to reduce the time of delivery between all important centres. Thus goods sent from Paris one day are ready for the public the next day at Lille, Valenciennes, Arras, Laon, etc. The same applies to coal trucks brought in the evening to the coal-yards. If these coal trucks are going to Paris, they are taken in eight hours by through trains which are not altered in any way or stabled during the journey.

The same journey by water requires at least fifteen days of travel. In fact the loss of time, either on the way, or while loading and unloading operations are going on, prevents a canal-boat from making more than four journeys per annum, although it has often been asserted, and with reason, that theoretically it could and should make five or six.

The advantage of the railway generally increases with the length of the journey.

Coal from the north going to	Time normally required for the journey	
	by rail.	by water.
Reims	2 days.	20 days.
Saint-Dizier	3 —	30 —
Epinal	4 to 5 —	50 to 60 —

The very long time required for water carriage makes their competition for the passenger and parcels traffic less and less serious.

Exceptional conditions are required to enable waterways to play any part in the conveyance of passengers. The case only arises on certain rivers on the Continent, on those sections which are accessible to large steamships. We may mention the use of the small river-steamers in large towns, the classical excursions on the Rhine, the long-distance services of the Danube Steam Navigation Company (which still carried 500,000 passengers in 1898, after having reached 1,800,000 passengers in 1890), and finally the long journeys on the Volga, where there are 400 fast steamships of up to 1,500 horse-power, capable of carrying 1,400 passengers and covering the 2,200 kilometres (1,367 miles) from Nijni-Novgorod to Astrakhan in five days.

As regards goods, quick-freight services by water are equally exceptional. Well-equipped services of this kind are however found on the large German and Austrian rivers. These services are operated by important steamship companies. They receive the quick-freight goods in small consignments, of from 50 to 1,000 kilograms (110 to 2,200 lb.).

The carriage of quick-freight separate packages only forms an unimportant fraction of the traffic at the upper Rhine ports (about 1 per cent); on the other hand, it forms nearly one third of the traffic at the middle Rhine ports (Cologne, Dusseldorf, etc.), leaving coal out of consideration. We may mention a daily service, in each direction, between Cologne and Rotterdam, leaving at 8 p. m. and arriving the next day at 3 p. m. on the down and at 5 p m. on the up journey. Another service between Rotterdam and Duisburg takes twenty-four hours up and fourteen hours down. This considerable speed enables the shipping to carry part of the traffic in more delicate goods, such as eggs and milk.

Quick-freight services are even more important as regards the Elbe shipping. The two most powerful shipping companies on that river (the " Vereinigte Elbeschiffahrts-Gesellschaften-Aktiengesellschaft " and the " Oesterreichische Nordwest-Dampfschiffahrts-Gesellschaft ") have formed a combine. They run fast boats, of 100 to 300 horse-power, to operate three parcels services :

1° Between Hamburg and Magdeburg and vice-versa; tariff of 25 March 1904; at least three journeys in each direction per week (Monday, Wednesday, Friday);

2° Between Hamburg and the Saxon ports (Riesa and Dresden) and vice-versa; tariff of 1 April 1904; at least three journeys per week in each direction; leaving Hamburg on Tuesday, Thursday and Saturday, and Dresden on Monday, Wednesday, Friday;

3° Between Hamburg and the ports on the upper Elbe : Laube and Tetschen; tariff of 15 January 1903; at least three departures per week from Hamburg and from Tetschen; on Tuesday, Thursday, Saturday.

The conditions and rates for quick-freight conveyance are given in official tariffs which consider three or four hundred different articles. Each rate is composed of two parts :

1° The freight proper (increased by 20 per cent when the water is low), varying principally with the space occupied, which depends on the specific gravity of the goods;

2° The insurance, varying with the value and the risk of damage to the goods, and equal on the average to 50 per cent of the freight.

Very complete and very precise regulations define the rights and the duties of the consignors and of the carriers. The tariffs are as a rule rather high; they generally exceed 3 centimes per ton-kilometre (0·47*d.* per English ton-mile) in either direction. This explains why these services are not utilized for large consignments; the truck-load rates of the railways are in fact generally cheaper, as soon as the consignments amount to 10,000 kilograms (22,000 lb.).

The journey from Laube to Hamburg, 630 kilometres (391 miles), takes three days down; the up-journey takes eight days. We accordingly see, that as far as long-distance traffic is concerned, the fastest waterway services, which may be as quick as the slow-freight railway services, are never as fast as the quick-freight railway services.

The canals of western Europe, being of small cross-section and having numerous locks, are not suitable for quick traffic. We may however mention the organization of the parcels traffic on the canal from Brussels to the Rupel towards Antwerp and vice-versa, where there is a daily steamship service. The goods carried by this accelerated service arrive at their destination the day after they have been handed to the shipping company. The latter also undertakes, when asked by its customers, to collect and deliver the goods at domicile. The freights, which are appreciably lower than the railway rates, vary from 30 to 50 centimes per 100 kilograms (2*s.* 5·3*d.* to 4*s.* 0·8*d.* per English ton) (according to size and consignment) for the carriage from quay to quay. Collection at domicile costs 30 centimes per 100 kilograms (2*s.* 5·3*d.* per English ton).

Leaving out of consideration these very exceptional accelerated services, we have to record that in the case of ordinary slow freight in barge-loads, the time of delivery is very variable, according to waterway. On our French canals, the daily progress of the boats varies between 10 and 20 kilometres (6·2 to 12·4 miles). The

Rhine boats take ten days for covering the 700 kilometres (435 miles) from Antwerp to Strasburg (70 kilometres [43·5 miles] per day); the Volga boats take thirty-five days for covering the 2,655 kilometres (1,650 miles) from Astrakhan to Rybinsk (75 kilometres [47 miles] per day).

The slowness of water carriage is a serious inconvenience to the merchants who make use of it. Air, damp, sun, depreciate certain goods; the effect increases with the time. In comparing different costs of carriage, manufacturers often take into account the loss of interest incurred if water carriage is used, being compelled to make their payments earlier as compared with the time at which their goods arrive at the place where they are wanted. According to information supplied by the French Eastern Railway, the corresponding charge, in the case of coal carried by water from the north to the upper Marne, may amount to about 0·35 franc per ton (3·41*d.* per English ton).

As water carriage is not only slow, but also irregular, its use almost necessarily entails the storage of a considerable quantity of goods, to fulfil the functions of a fly-wheel and provide for a regular supply to the industries concerned. The possibility of keeping a stock easily and economically is then an absolute necessity if water carriage is to be used.

It may happen on the other hand, that the time required for the journey may be an advantage to the merchant, instead of an inconvenience. This happens in the case of certain goods, such as imported corn, which arrives in large quantities, sent as soon as gathered and intended to be gradually resold in smaller quantities without any change; the wholesale merchants gain no advantage in receiving it at once and seek to prolong the cheap storage obtained on the boat until the purchaser desires to take delivery.

V. — Nature of the goods.

Certain goods present, by their very nature, special disadvantages or advantages from the point of view of water carriage. Among the goods which suffer if carried by water, we must in the first place mention coal and coke.

a) Coal is a fuel whose calorific value alters very rapidly. A somewhat prolonged exposure to damp air, to sun or to frost produces a rapid disintegration, similar to that produced by the action of heat. A coal company in the north of France has found that after it had been stored six months, screened and picked coal gave 18 to 20 per cent of smalls, and that after one year the proportion of smalls had increased to 30 per cent.

Water carriage, which necessitates more frequent and rougher handling, is for this reason also not favourable to the preservation of the coal. It has been found that rough pit coal, after having been carried from the Pas-de-Calais to Paris by rail, if screened on a 3-centimetre (1 $^{3}/_{16}$ inches) screen, left 70 to 75 per cent of

pieces on the screen, while after it had been conveyed by water, it only gave 55 to 60 per cent.

Finally the dampness of the coal favours its heating, which again impairs its calorific value. This loss may amount to from 5 to 10 per cent, owing to the long time the water carriage takes.

These phenomena have been described in a noteworthy report by Mr. Gruner, submitted to the International Shipping Congress of 1902. This author concluded that in the case of industrial coal for direct consumption, it must be assumed that the extra cost of handling due to water carriage is 1 to 1·25 franc per ton (9·75*d.* to 1*s.* per English ton), and that the losses resulting from the alteration of coal arriving in large quantities, and not as when required, amount to 2 or 3 francs per ton (1*s.* 7·5*d.* or 2*s.* 5·3*d.* per English ton).

According to information personally obtained from Mr. Weyhemmayer, manager of the *Kohlen-Kontor*, the loss of value of the fuel may vary between 5 and 9 per cent, being greatest in the case of house coal and coke, and very low in the case of washed coal.

It must however be remembered that manufactories have to keep a stock, with a view to the occurrence of a strike, and that often the absence of room makes them prefer to have a floating stock. On the other hand, if the consignee is a coal dealer, he utilizes the smalls in the manufacture of briquettes. Finally, the customers of the retailer have no means for checking the value of the coal they receive, with any accuracy, and pay the same price for it in spite of the deterioration which a manufacturer who has to reduce his net cost has to take into account. These circumstances sometimes lead to the preference of waterways in cases where the difference between the rates does not seem to justify this choice.

b) The alteration, chiefly physical, of the coke is generally greater than in the case of coal.

Mr. Gruner considers water carriage disadvantageous unless it results in a saving of more than 2·50 francs (2*s.*) per ton. Mr. de Lespinats, ironmaster at Neuves-Maisons, on the basis of long comparative experiments on the two systems of carriage, estimated this difference at 1·40 franc (1*s.* 1·7*d.*) per English ton a few years ago. Mr. Guérin, member of the Nancy chamber of commerce, who recently repeated this calculation, arrived at 1·90 franc (1*s.* 6·5*d.*) per English ton.

In this connection it may also be noted that the coke which formerly reached the works of the Nancy district (Maxéville, Frouard, Pompey, Pont-à-Moussons, Neuves-Maisons) entirely by water, has nearly entirely abandoned that way. The only notable exception is the supply to one part of the Neuves-Maisons works, which is favoured by an exceptional position.

c) Water carriage can also have certain disadvatages in the case of cereals. Very dry corn travels very well in canal-boats for one or two months without being affected, if the boat is very water-tight. But if it is at all damp and loaded in bulk,

it is liable to ferment and spoil. In any case, water carriage always presents more risks, from the point of view of the preservation of goods, than railway carriage. In order to keep the corn well aired, a certain number of passages are often left, which reduce the capacity of the boat.

Water carriage on the other hand has advantages for millers. Offers of corn do not come regularly to them all the year round, and a boat has the advantage of acting as a floating store, of preventing obstruction at stations and on sidings, of gradual arrival at the mills, so as to avoid sudden rushes of labour.

Water carriage has a notable advantage when it is a question of bringing cereals imported at seaports to the inland centres of consumption. The canal-boats only have to go alongside the importing vessels in order to be fully loaded up. It is even useless to place the cereals in sacks; a double economy results, in loading and in unloading, and transhipment in bulk is effected very economically.

VI. — Value of the goods.

A very general opinion divides goods into two classes; the first, consisting of heavy goods of little value, would naturally use waterways; the second including light and valuable goods, would suit railways.

This distinction has no real basis, as can be easily explained.

Systematically or not, more or less definitely according to case, the system of railway tariffs is based on an estimate of the rate the consignment can pay, according to its value to the consignor. Under normal conditions, this value of the carriage varies in the same way as the value of the goods, so that the latter is the principal basis of classification, and the difference between the rates applied to different articles is often very great.

On waterway, on the other hand, the competition of the shipping reduces the freight down to near the actual cost of the carriage. No doubt this cost increases a little with the greater responsibility and care required in the case of more valuable goods, but the corresponding difference is not great. Consequently in the case of goods of a certain value there is most advantage, from the point of view of cost, to use the waterways, as long as the railways retain their ordinary system of rating and are not led to make special tariffs on the routes where there is competition. This only ceases to be the case if the goods are of very great value, in cases in which a saving of several francs in the cost of carriage does not compensate for the different disadvantages of water carriage. This may thus perfectly apply to goods of medium value.

On the other hand, it is wrong to say that heavy goods do not suit a railway, for in fact it often carries them at the same rate as a waterway, or even at less, when it is satisfied with making a very small profit in order to contribute towards covering its general expenses, as we will show further on.

The table below shows how the traffic on the French waterways was made up in 1907 :

CLASS OF GOODS.	Tonnage of goods shipped (in tons).	Average distance (in kilometres [in miles]).	Total traffic (in ton-kilometres [in English ton-miles]).
1. Mineral fuel	10,965,000	228 (142)	2,504,000,000 (1,531,000,000)
2. Building materials	12,073,000	77 (48)	929,000,000 (568,000,000)
3. Manure and fertilizers	1,570,000	69 (43)	108,000,000 (66,000,000)
4. Raw materials, for metallurgical purposes	1,717,000	191 (119)	328,000,000 (204,000,000)
5. Wood for burning or using — shipped	1,730,000	166 (103)	288,000,000 (176,000,000)
5. Wood for burning or using — rafts	135,000	53 (33)	7,000,000 (4,300,000)
6. Metals and machines	759,000	305 (190)	232,000,000 (142,000,000)
7. Industrial produce	1,156,000	273 (170)	316,000,000 (193,000,000)
8. Agricultural produce and food	4,268,000	145 (90)	618,000,000 (378,000,000)
9. Miscellaneous	329,000	125 (78)	41,000,000 (25,000,000)
Total and mean	34,701,000	154 (96)	5,371,000,000 (3,284,300,000)

The four first classes include heavy goods, almost exclusively. The goods in classes 6, 7 and 8 are often worth 50 to 100 francs (£2·0*s.* 7*d.* to £4·1*s.* 2*d.* per English ton) and must be considered as of medium value. Class 5 may be considered as of either category, as it includes on the one hand wood for constructional purposes, often worth more than 50 or 100 francs per ton (£2·0*s.* 7*d.* to £4·1*s.* 2*d.* per English ton), and on the other hand, wood for burning and scaffolding of lower value. Although the division made is not strict, we may assume that the errors resulting in class 8 from the presence of articles of food of low value, such as beet-roots, etc., and in class 2 from the presence of articles of a higher value (ashlar, hydraulic lime, etc.) compensate each other. The following division may accordingly be considered as very near :

	Ton-Kilometres.	(English ton-miles.)	
Heavy goods	4,061,000,000	(2,484,000,000)	75 per cent.
Goods of medium or higher value	1,310,000,000	(801,000,000)	25 —

The second division is hence far from being negligible.

It is easy to show, on the other hand, what considerable part is taken by the French railways in the heavy-goods traffic; mineral fuel, which represents 32 per cent of the waterway traffic, forms 28 per cent of the railway traffic; manure

represents 4·3 per cent of the waterway traffic and 5·5 per cent of the railway traffic.

Building materials form the most favoured class as far as waterway traffic is concerned; they constitute 35 per cent of its traffic, while forming only 15 per cent of the railway traffic. This is easily explained; for part of the goods of that class (sand, gravel, etc.) are obtained by dredging.

But these general statements include the railway traffic in the purely agricultural districts, where the heavy-goods traffic is negligible in amount; we find the proportion of heavy-goods carried by rail much greater if we limit the comparison to the waterways and the railways of the north.

	Tonnage carried	
	by rail.	by water.
Coal	15,332,640	7,008,000
Building materials	1,656,000	1,572,000
Manure and fertilizers	1,328,000	616,000
Raw materials for metallurgical purposes	817,000	355,000

Among goods of a certain value carried by water, we must in the first place mention corn and wine, particularly if imported by sea; then textiles and soft goods, groceries and finally the 40,000 tons of mineral waters transhipped at Roanne. Some of the goods, such as corn, wine, sugar, cottons, are often sent in full bargeloads. Others are generally in broken loads, and the shipping cannot deal with them unless regular and quick services are organized; two conditions have to be observed :

1° A satisfactory *commercial organization*. A trader will hardly entrust objects of a certain value to an individual boatman, making some journey or other. He must be able to address himself to a responsible shipping company, having boats starting at fixed dates, installations at the large ports, and representatives charged with looking after customers, attending to the handling and if necessary to the cartage. The chief company of the sort in France is the Havre-Paris-Lyons-Marseilles Company. It has succeeded in obtaining the best locations at several ports, and in creating for itself a sort of half-monopoly, which enables it to fix its rates, not according to the net cost, under the compulsion of competition, but according to the railway rates, allowing in the latter varying reductions (10 to 30 per cent) which experience shows sufficient to attract the traffic which can go by water. It sometimes makes contracts with its customers.

2° A *satisfactory speed*. Regular service can accordingly only be operated with

success on lines where travelling is easy, either because there is not much traffic on them, or because they offer exceptional technical advantages. In France the canals in the centre and in the south, and the Rhone and the Saone, can be included in the former class; the Seine belongs to the latter.

An important part of the articles of value is carried on steamboats which can operate a quicker service than ordinary canal-boats. The following table is compiled from the French official statistics for 1907 :

Class of goods.	Weight shipped.		Proportion per mil.	
	Steamboats.	Ordinary boats.	Steamboats.	Ordinary boats.
1. Mineral fuel	99,676	10,865,126	9	991
2. Building material . .	23,913	12,049,168	2	998
3. Manure and fertilizers .	3,405	1,566,304	2	998
4. Wood for burning or for using	64,218	1,800,690	34	966
5. Metal and machines. .	16,491	742,344	22	978
6. Raw materials, for metallurgical purposes	3,003	1,713,659	2	998
7. Industrial produce . .	70,393	1,085,889	61	939
8. Agricultural produce and food	240,603	4,027,257	56	944
9. Miscellaneous . . .	124,726	204,750	379	621
All goods. . .	646,428	34,055,187	18	982

The large German and Austrian rivers are more suitable for the carriage of valuable goods than most of our railways. In Germany, there are powerful shipping companies, representing an invested capital of more than 80 million francs (£3,200,000), who continually improve and add to their boats. They form among themselves more or less permanent combines, which enable them to raise their rates somewhat. They particularly cater for articles of value.

As an instance, let us take one of the chief Rhenish companies, the "Badische Aktiengesellschaft", which possesses a fleet of seventy boats. In 1906 it carried 225,000 tons down river, two thirds of which represented goods of a certain value (cement, phosphates, salt, cables, rails) sent in full boat-loads, while one third consisted of broken loads; its up-river traffic amounted to 400,000 tons, two thirds of which consisted of cereals, and the rest of cement, timber and sundry goods.

The Elbe traffic includes a still greater proportion of articles of value, particularly down river where it is entirely in the hands of a combine formed by two large com-

panies, as mentioned above. These even make contracts by the month or by the year with the manufacturers and traders of Saxony and of Bohemia in order to make sure of their customers. Thanks to this monopoly, the down-river freight is kept much higher than the up-river freight, although the cost of traction is much less. The up-river rates are in fact limited by the competition of individual boats and of a third less powerful company, the " Elbe Dampfschiffahrtgesellschaft ", of Hamburg.

The following are the principle articles constituting the traffic of the Elbe companies, the goods urgently required utilizing the quick-freight services described above.

Up river, we remark colonial goods (cotton, guano, cigars, rice, coffee, cocoa, cochineal, rubber, indigo, silk, tea), foreign goods (cereals, petroleum, sugar), chemical products, provisions (beer, butter, champagne, lemons, honey, margarine, liquors, tapioca) and manufactured goods (bicycles, American agricultural machinery, sewing machines, pianos).

Down river, the chief articles are sugar, paper, cellulose, Bohemian glass, mirrors, bottles, cereals, oils, bent-wood furniture, china, mineral waters, cognac, chocolate, biscuits.

The 1892 International Shipping Congress had placed on its agenda the examination of the comparative functions of waterways and railways. The German reporters, Messrs. Van der Borght and Dr. Landgraf for the Rhine, Mr. Pescheck for the Elbe and Oder, arrived at the same conclusion as we did; on railways as on waterways, heavy goods predominate, but nearly in the same proportion; shipping takes its share of valuable goods.

This opinion has lost none of its accuracy. The Danube in this respect approximates to the German rivers. The chief part of its traffic consists of cereals, going up river. The current prevents the quick progress of boats in this direction, and makes it impossible to carry fresh articles of food long distances, especially plums and flour. Down river, on the other hand, the boats go fast, there is less traffic and the shipping companies cater by preference for articles of value (cotton, iron, etc.). The Danube Steam Navigation Company is the preponderating factor on the Danube. Its traffic consists, to the extent of 40 per cent, of cereals going up river, and to the extent of 40 per cent, of manufactured products going down river.

In short, wherever shipping finds the topographical conditions favourable and has a proper commercial organization, it can compete with the railway for all goods, except those of very high value.

VII. — Characteristics and habits of the " clientèle ".

We have already stated that the railways are just as suitable as the waterways for carrying large consignments. The tariffs for sets of wagon or for train-loads make it possible to form larger units than single truck-loads and better suited to the needs of large manufactories or of wholesale trade. But at the same time, the whole train

*

can be made up, if required, of a number of small parts, so as to cater for all needs. The railway can, if it desires, change the unit according to town and district, reckoning at one point in hundreds of tons, at another in single kilograms. Shipping is much less able to cope with such a divided and varied service. It includes among its customers far fewer retail traders and private persons. It is in this sense that the following sentence may be understood: " To the waterway the merchandise, to the railway the merchant. "

The average size of a consignment sent by water in France corresponds nearly to the full load of a canal-boat, namely 250 to 300 tons. On the French Eastern Railway, which however takes an important share of the industrial traffic, the average weight of each consignment is 3 to 4 tons. If we consider the French Northern Railway, where the heavy traffic predominates, and if we determine the average weight of a consignment of coal, we find that it is between 16 and 17 tons.

It will be remembered, it is true, that the quick services on the Rhine, the Elbe and the Danube, take broken loads; but here again two different things must not be confounded under the same name. On waterways, everything is called a broken load which does not represent a barge-load. Consignments of 5 and even 10 tons are called broken loads, whereas the latter form the ordinary unit (truck-load) in the case of the larger consignments sent by rail.

We give some illustrations of this preference of traders of small or medium importance for railways.

The first example will be a comparison of the corn trade on the Volga and that of St. Petersburg. The corn trade on the Volga is in the hands of very powerful and very rich millers who prefer to reduce to a minimum the time they have to devote every year to their consignments of corn; they accordingly buy the corn in the productive districts of south Russia and store them at the Volga ports; then as soon as they think freight is low and prices are high they have the whole lot brought in one consignment. On the other hand, at St. Petersburg the corn trade is in the hands of much less powerful representatives of Germany, who cannot lock up so much capital at once and consequently are interested in spreading out their consignments and their payments; and accordingly they are customers of the railway.

The Belgian State Railway mentions a similar phenomenon on the Mons canal, where the coal consignments, formerly very large, have become insignificant since the coal trade, which was formerly in the hands of a few very important firms, have become divided up into a number of small firms.

A curious instance of the reaction of commercial habits on the choice to be made between the two ways is mentioned to us by the Bavarian State Railway. This tells us that the Main only plays an insignificant part in the carriage of planks, because the commercial unit of sale corresponds to a truck-load.

The organization of the coal trade in south Germany exercises a marked influence on the importance of the traffic sent by water. We know that in connection with the Westphalia syndicate there has been formed an organization for carrying and

distributing the coal to south Germany, Alsace-Lorraine, Bavaria and Switzerland. The *Kohlen Kontor*, as this organization is called, refuses to sell coal to merchants except by boat. It thus obtains both the profit on the sale of coal and the profit of shipowner. The latter profit is far from negligible. Mr. Peters points out in fact, that the freight for coal from Ruhrort to Mannheim has increased by 1·25 francs per ton (1*s.* per English ton) since the *Kontor* has come into existence.

A similar organization which operates Silesian coal on the Oder, also somewhat favours the waterways.

The German paper the *Zeitschrift für Binnenschiffarht* on the other hand mentions that the Prussian State, which owns some salt works, arranges matters so as to sell salt only in trucks-loads.

Finally we mention that on the Rhine, certain ship owners of Rotterdam, in order to insure that their cargo-boats have profitable cargoes, carry goods on the river at cost price or even at a slight loss, and this favours shipping.

VIII. — Importance of the places of origin and of destination.

As a general rule, goods carried by water are, as far as the greater part of them is concerned, either coming from or going to large towns or important centres; the traffic of secondary towns and ports forms a smaller fraction of the total waterway traffic than the traffic of secondary towns forms as compared with the total railway traffic.

The points from which goods are sent by water are as a rule mining or industrial centres, or large seaports. The places to which coal or raw materials, which form the chief part of the water-borne traffic, are sent, are manufactories generally concentrated in certain districts. Those to which building materials and imported agricultural produce go are the large cities, centres of population. It is rare that small localities possess merchants capable of buying and selling quantities of corn, salt, sugar, petroleum, sufficiently large to form a barge-load.

The predominating influence of the large centres on the waterway traffic explains itself quite naturally, if we think of the considerable number of large towns which became developed on large rivers, at times when artificial ways of communication were very undeveloped and when the banks of those rivers were, as far as the inlands were concerned, the sole points accessible to heavy traffic without excessive expense.

There are exceptions to this general statement. The sugar refineries, which receive their beetroot and their coal by water, are often in the country. Frequently also the point of destination of water-borne traffic is situated where orografical conditions stop navigation. Hence the importance of the port of Cosel on the Oder, of the port of Lauterburg on the Rhine, where Westphalian coal for the south of Germany is unloaded when the water is too low to make it possible to go to Strasburg.

We can give some figures which confirm our statement. The Midi Railway finds

that on the Garonne, nine tenths of the traffic are to or from Bordeaux, and on the Midi canal three quarters of the traffic are from or to the four principal centres.

The French Eastern Railway has compiled an interesting table which we reproduce below and which shows the relative importance of the railway and waterway traffic on the important line between Paris and Strasburg. This table only includes the towns and industrial centres which in 1906 had a traffic exceeding 100,000 tons. We have included with Nancy its industrial suburbs, namely Jarville, Frouard and Champigneulles.

The percentages vary from one station to another; there is nothing abnormal about this, particularly in the case of stations of secondary importance; frequently, in fact, their whole traffic comes from one single works, which according to location and equipment, gives the preference to the one or to the other way. But it must be remarked that taking it altogether, the waterway percentage is considerable and materially exceeds that which one would find for the total traffic of the district by the Eastern Railway, which the company estimates at about 22 per cent. We find that this average is not attained or is scarcely surpassed in the case of even important towns which, not being chiefly industrial, are above all centres of consumption, such as Chalons, Toul, Bar-le-Duc, Vitry-le-François; waterways only share to any large extent in the arrivals.

This is moreover also the case as regards Paris. The table below shows the development of the traffic of the port of Paris as compared with the slow-freight traffic at the Paris stations. The exceptional rush in the waterway traffic in 1899 is explained by the arrival of materials and the carrying away of rubbish in connexion with the Universal Exhibition, on the banks of the Seine. The year 1906 marks the beginning of a probably more durable progression in the arrivals resulting from the development of the consumption of English coal in Paris, which began at the time of the last coal famine and has continued since. As regards the appreciable increase in the dispatches since 1902, this is partly due to the removal by water of material excavated during the construction of the metropolitan railway.

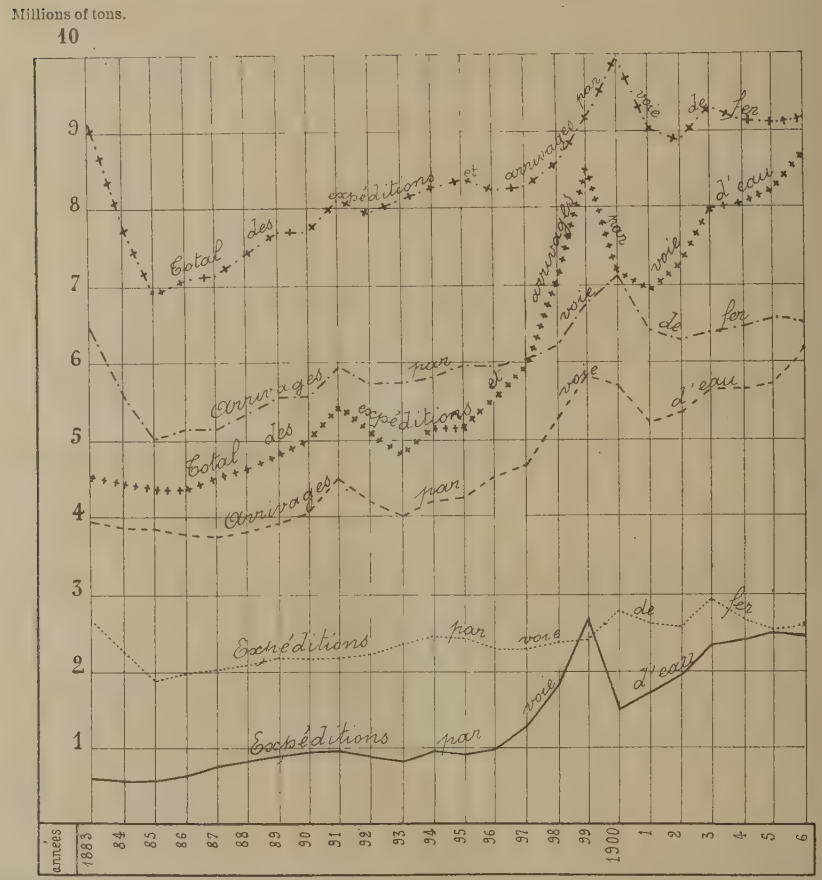
At Berlin, as at Paris, the part played by the waterways is considerable, particularly as regards arrivals. In order to have an exact idea of the situation, we must add the traffic at the neighbouring ports of Charlottenburg to the traffic at the port of Berlin, and to the railway traffic we must add the tonnage of the stations in the immediate suburbs of Berlin (service traffic excluded). Thus for instance for 1903 we obtain the following figures :

	Railways.	*Waterways.*
Total tonnage	9,600,000 tons.	9,157,000 tons.

While the total traffic is about the same in both cases, the arrivals form three quarters of the railway traffic and nine tenths of the waterway traffic.

Place on the Marne and on the canal from the Marne to the Rhine.	Dispatched.					Arrived.					Dispatched and arrived.				
	Total tonnage.	Waterway.		Railway.		Total tonnage.	Waterway.		Railway.		Total tonnage.	Waterway.		Railway.	
		Tonnage.	Per cent of total tonnage.	Tonnage.	Per cent of total tonnage.		Tonnage.	Per cent of total tonnage.	Tonnage.	Per cent of total tonnage.		Tonnage.	Per cent of total tonnage.	Tonnage.	Per cent of total tonnage.
Nancy and suburbs (Jarville, Frouard, Champigneulles)	839,700	435,700	51·89	404,000	48·11	1,714,000	389,000	22·70	1,325,000	77·30	2,553,700	824,700	32·29	1,729,000	67·71
Varangéville St. Nicolas (various ports)	501,300	176,100	35·13	325,200	64·87	774,300	704,200	90·95	70,100	9·05	1,275,600	880,300	69·01	395,300	30·99
Chalons on the Marne	73,100	6,800	9·30	66,300	90·70	273,200	75,600	27·67	197,600	72·33	346,300	82,400	23·79	263,900	76·21
Épernay	121,400	27,200	22·41	94,200	77·59	209,900	32,300	15·39	177,600	84·61	331,300	59,500	17·96	271,800	82·04
Meaux	126,000	71,400	56·67	54,600	43·33	124,200	40,400	32·53	83,800	67·47	250,200	111,800	44·68	138,400	55·32
Toul (different ports)	42,400	11,000	25·94	31,400	74·06	137,600	51,600	37·50	86,000	62·50	180,000	62,600	34·78	117,400	65·22
Bar-le-Duc	45,600	4,000	8·77	41,600	91·23	101,900	24,500	24·04	77,400	75·96	147,500	28,500	19·32	119,000	80·68
Vitry-le-François	60,500	4,500	7·45	56,000	92·55	84,500	26,800	31·72	57,700	68·28	145,000	31,300	21·59	113,700	78·41
Sermaize	64,000	19,200	30·00	44,800	70·00	60,300	49,200	81·59	11,100	18·41	124,300	68,400	55·03	55,900	44·97
Foug	59,000	5,700	9·66	53,300	90·34	59,400	34,200	57·58	25,200	42·42	118,400	39,900	33·70	78,500	66·30
Château-Thierry	51,500	26,600	51·65	24,900	48·35	51,800	5,600	10·81	46,200	89·19	103,300	32,200	31·17	71,100	68·83

Fig. 5. — **Dispatches and arrival at the port and at the stations of Paris.**



Explanation of French terms : Années = Years. — Total des expéditions et arrivages par voie de fer = Total of dispatches and arrivals by rail. — Total des expéditions et arrivages par voie d'eau = Total of dispatches and arrivals by water. — Arrivages par voie de fer = Arrivals by rail. — Arrivages par voie d'eau = Arrivals by water. — Expéditions par voie de fer = Dispatches by rail. — Expéditions par voie d'eau = Dispatches by water.

We have left out of consideration the transit waterway traffic which attained 1,400,000 tons in that year.

If we made the same calculation for the other large German towns : Hamburg, Duisburg, Frankfort, Ludwigshafen, Mannheim and Breslau, we should find that shipping takes from 40 to 60 per cent of the whole traffic.

The waterway traffic is also important at Budapest, forming nearly one quarter of the whole traffic; it includes more particularly half the cereals traffic. The waterway share increased since 1885, as compared with the railway share.

IX. — Part played by the two systems of carriage as regards imports and exports.

Waterways generally play a very important part as regards imports. We are of course only referring to imports by sea, as at inland frontiers the excess of imports or of exports for one of the two nations is counterbalanced by an equal deficit for the other.

This preference of imports for waterways is explained more particularly by the fact that goods arriving by cargo-boat are in an excellent state for economic transhipment to barges. That is a real superiority of the waterways, whose effect is recorded by the Orleans Railway at Bordeaux, by the Midi Railway at Cette, by the French Western Railway at Havre and at Rouen, and by the French State Railway at Cognac.

This advantage is more especially greatly in favour of the waterway in the ports at estuaries, where the cargo-boat can come into the river in order to tranship, direct and in bulk, its cargo into a number of barges which come alongside.

It is more particularly on the Seine that this phenomenon is to be observed in France. The three curves in the diagram below show how the division of the coal, the wine and the corn traffic has varied since 1885.

Figure 6 shows the up coal traffic from the ports of Rouen and Havre and from the stations of Rouen, Havre and Dieppe. The superiority of the waterways is evident. On the other hand, we have seen that in the northern districts where however there are ample waterways, more than two thirds of the coal traffic was by rail, no doubt owing to the greater facility of loading up trucks which can go to all parts of the coal-pit. We also mention, in the case of imported-coal traffic, a remarkable instance of a rather frequent case, that of competition between a waterway and a railway not parallel to it, competing for traffic which can arrive by sea at different ports : that is the port of Dieppe which formely received and handed over to the railway the traffic which now goes via Rouen and the Seine.

In the case of cereals (fig. 7), the waterways also take an important part of the traffic. It is to be noted that the share of the railway is generally greater in the case of traffic leaving Havre, and that of the waterway in that of traffic leaving Rouen, although the difference between the rates of the methods of conveyance is the same (about 1 franc [9·75*d*. per English ton]), from Havre to Paris and from Rouen to Paris. This confirms the special aptitude of river ports in enabling the transhipment of goods in bulk to be effected under good conditions. The total quantity of cereals imported at Rouen and Havre has however materially diminished owing to the growth in home production; it fell in fact from 1 million tons in 1891 to 400,000 tons in 1906.

Finally figure 8 shows the absolute preponderance of the waterway in case of wine imported by the Seine. We do not give the figures for Rouen and Havre separately, as they are unimportant in the latter case. The important variations found are due to inequalities in the harvests.

Fig. 6. — **Coal sent from Havre, Rouen and Dieppe.**

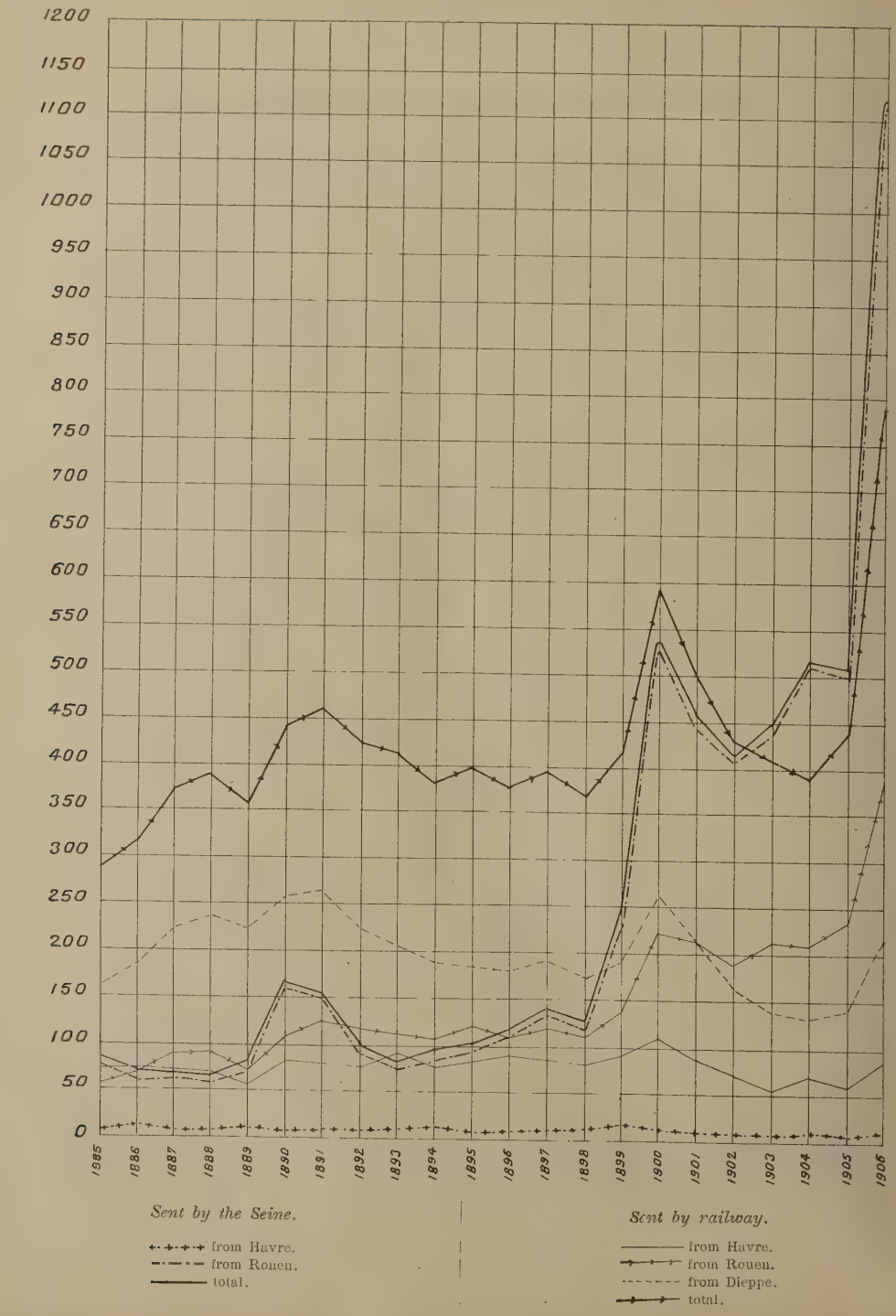


Fig. 7. — Cereals sent from Havre and Rouen.

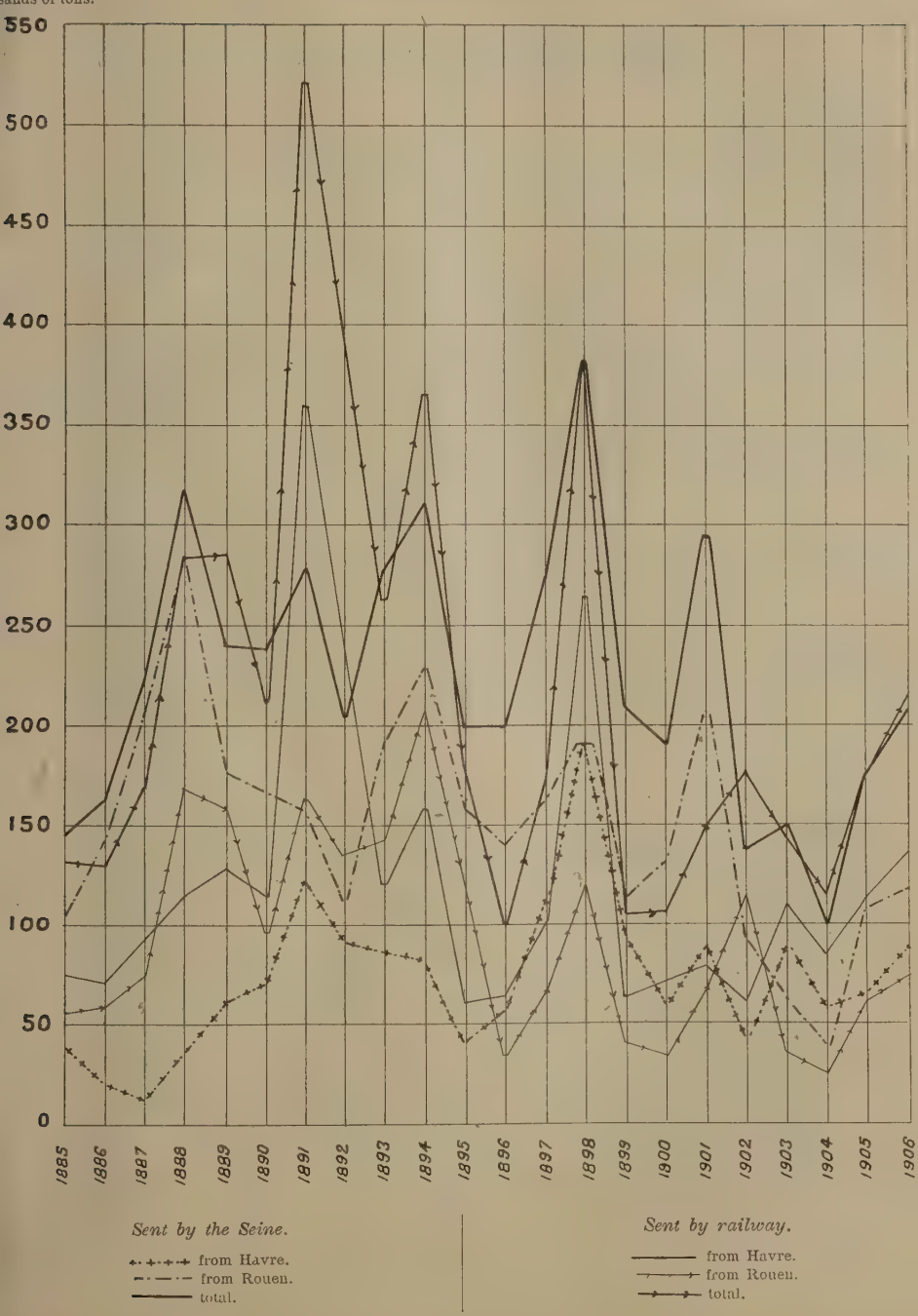
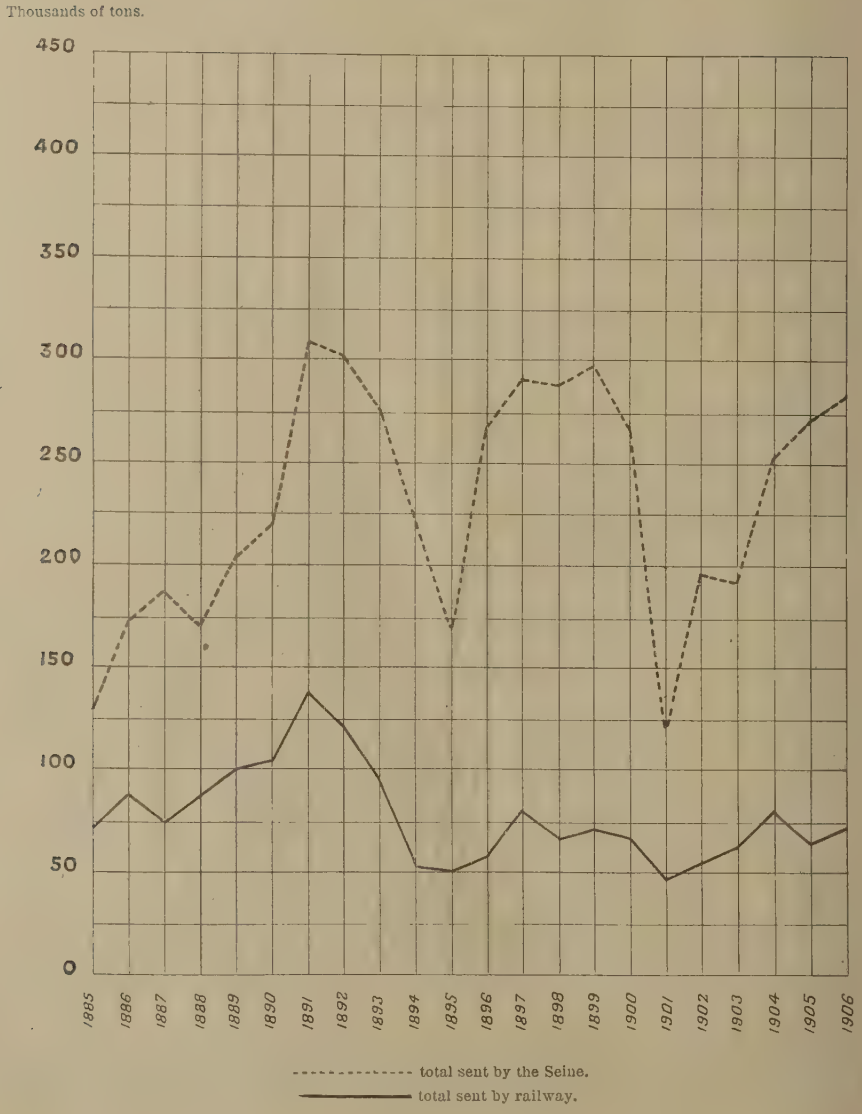


Fig. 8. — **Wine sent from Havre and Rouen.**



The same preponderance of the Seine shows itself, more and more markedly, in the case of imported foreign timber, as the following table shows :

	1885. Tons.	1906. Tons.
Timber dispatched from Dieppe station.	70,000	23,000
— — — Havre station	70,000	61,000
— — — Rouen station	8,000	59,000
Total sent by rail. . .	148,000	143,000
Timber sent by boat from Havre	2,000	20,000
— — — Rouen	22,000	180,000
Total sent by water. . .	24,000	200,000

We find similar results in Germany. Taking it altogether, the waterways in 1875 imported 3,800,000 tons as against 2,600,000 tons exported; and in 1905, they imported 20,000,000 tons as against 10,600,000 tons exported.

On the Rhine, at the Dutch frontier, in spite of the considerable export traffic in Ruhr coal (4 million tons), the tonnage of imports is 13 million tons, as against exports of 8 million tons (1905).

On the lower Elbe, we find 4,800,000 tons imported as against 3,200,000 tons exported. On the Dortmund canal at Ems, we find 500,000 tons of arrivals as against 250,000 tons of dispatches, and on the Oder 2 million tons as against 900,000 tons.

It is not remarkable that the imports exceed the exports, as Germany is an importing country. But the preponderance of imports is much greater in the case of waterways than in that of railways. The following table for 1900 (in millions of quintals) referring to the port of Hamburg shows this :

	By water.	*By rail.*
Imports	34	13
Exports	26	23

The same observation could be made as regards arrivals of coal and lignite at Berlin, as the following table referring to the year 1905 shows :

		By rail. Tons.	*By water.* Tons.
Coal and coke.	England	131,000	703,000
	Westphalia	160,000	137,000
	Saxony	46,000	...
	Upper Silesia	1,040,000	836,000
	Lower Silesia	320,000	70,000
	Total	1,697,000	1,747,000
Lignite.	Bohemia	23,000	16,000
	Prussia and Saxony.	1,619,000	7,000
	Total	1,642,000	23,000
	General total . . .	3,339,000	1,770,000

We here see that it is the imported English coal which takes most readily to the waterways, which the home coal from Silesia and the lignite from Saxony can however readily use.

But it is above all in the case of imported cereals that the German waterways have acquired a sort of monopoly. This largely depends on the economic transhipment of the cereals in bulk at the river ports. Mr. Peters states that at Hamburg, the cost of transhipment from cargo-boat to wagon is by itself as great as the carriage by water, all handling included, right up to Berlin. On the other hand the protectionist policy opposes any reduction in the tariffs applied to cereals when they are imported. Here are some instances of the different costs of carriage of a ton (per English ton) of corn :

	By rail.	*By water.*
From Rotterdam to Mannheim	23·00 francs (18*s.* 8·3*d.*)	3·00 francs (2*s.* 5·3*d.*)
From Rotterdam to Duisburg	9·30 — (7*s.* 6·7*d.*)	2·50 — (2*s.* 0·4*d.*)
From Hambourg to Magdeburg	15·50 — (12*s.* 7·2*d.*)	4·00 — (3*s.* 3*d.*)

Under these conditions it is intelligible that of the cereals imported into the Rhine basin in 1906, only 100,000 tons came by rail while 3 million tons came by water.

It is natural that the facilities of transhipment from sea-boat to river-boat should have more effect in the case of imports than of exports, because imported goods arrive in large quantities and can be at once reforwarded to the large inland centres, while the exported goods, starting from the points of production, in smaller lots, must gradually be gathered together to form the cargo of a sea-boat. Coal starting from neighbouring coal-pits forms nearly the only exception to this rule.

In spite of these less favourable conditions, the railways might attempt to retain the traffic by reducing their rates, both in the import and in the export direction. But here an obstacle arises which is of considerable importance : the influence exercised by the public authorities, influenced by protectionist tendencies, on the railway tariffs; either the State fixes these tariffs direct on the lines it operates itself, or else it controls them as in France in the case of lines for which concessions have been granted, or finally it intervenes by legal provisions as in certain countries. Public opinion and public authorities are everywhere clamouring for reduced export rates on railways, while always opposing reductions in import rates, even if the sole object of that reduction is to bring back part of the traffic to the railway, by offering advantages similar to those found on waterways.

The impossibility of influencing the traffic on the latter by differences of rate according to direction, and also the exceptional facilities they offer to the importation of agricultural produce, while the home farming, dispersed over the whole surface of the country, profits but little from the construction of canals which are only useful to a very limited part of that surface, explain the hostility of protectionists and farmers against waterways in many countries, particularly in Germany.

It is more difficult to understand the attitude of the protectionists who in some countries, particularly in France, recommend the construction of waterways, while energetically protesting against the least reduction in the rates by the railways, to enable the latter to retain the traffic the waterways take away from them.

X. — Disturbance in the equilibrium between the two systems of carriage.

All the different factors we have been considering tend to produce a state of equilibrium, a normal division of the traffic between the two systems of carriage; but that state of equilibrium is frequently disturbed.

Certain causes of trouble are connected with the policy adopted by the administrations which operate the railways or control them; these we will consider in chapters XI and XII. We will here only consider causes independent of all human will; there are three principal ones:

1° The stoppage of the waterways;

2° The variations in economic activity in accordance with the season of the year;

3° The long-period variations in that activity, that is to say the periods of industrial booms and the slumps which succeed them.

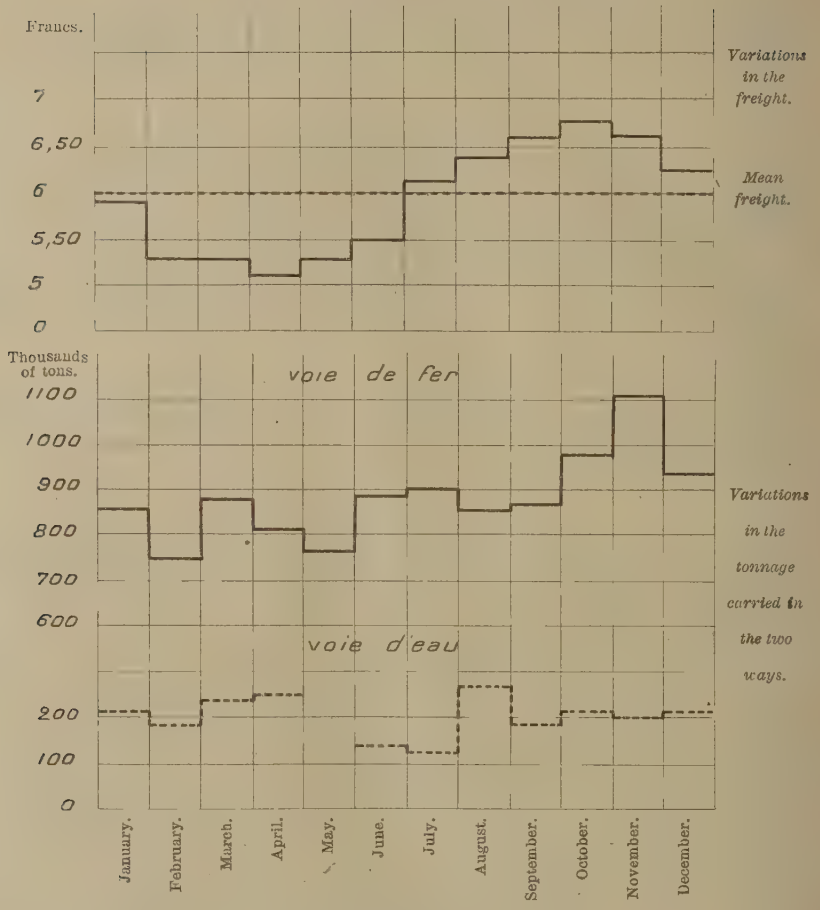
1° Part of the stoppages is due to frost. The duration of these interruptions varies in different climates, but it is generally foreseen by the consignors who make arrangements to send their consignments in good time. Thus they produce but little variation in the division of the traffic, except in years when they are of abnormal length.

The canals are sometimes stopped for the execution of works; this becomes rarer and is generally known in advance with complete exactitude.

River traffic on the other hand is liable to partial or total stoppage, for periods which are more irregular as to date and as to duration, owing to low water. Such stoppages last sometimes for many months, for instance on the upper part of the Rhine, the Elbe and the Oder. On the Rhine and the Elbe, the economy effected by using the waterway is sufficiently great that of the goods which generally go by water, only those of high value and urgently required go by rail when the river cannot be used, instead of waiting for a more favourable season.

Taking the general case, the stoppage brings the railway an extra amount of traffic; but this is not always an advantage to the railway, when that extra amount comes at a time when its own proper traffic is exceptionnally brisk, as quite frequently happens. This disadvantage is mentioned in France by the French Eastern and the French Northern railways, who state that the stoppage due to ice is generally coincident with the time of the heavy traffic in coal and beetroot. The Austrian and Hungarian railways also mention that the stoppages on the Elbe, the Danube (three months) and its tributaries the Tisza (four months), the Drave and the Save (five months), occur in autumn, just when the railway has most to do.

Fig. 9. — **Carriage of coal from Lens to Paris in 1898.**



Explanation of French terms: Voie de fer = Railway. — Voie d'eau = Waterway.

2° During the course of one and the same year, the activity of the traffic varies according to time and season. But the traffic-capacity of the boats remains the same; owing to the slowness of their progress, they cannot make a greater number of voyages. The waterway practically cannot take any of the extra tonnage offered; the sole effect of the increase in the demand is to make freight go up, and this difference displaces the point of division between the two ways, by sending the excess the waterway cannot take, to the railway, which is compelled to carry all traffic

which turns up, at its usual rates and inside the regulation time. The diagrams above (fig. 9), drawn by the French Northern Railway for the year 1898 (a normal year), show that in autumn the freight for coal rises; but it is the railway which carries the extra tonnage.

3° A similar phenomenon is produced, marked by oscillations of greater amplitude, owing to the variations in the economic activity from one year to the other. We now observe in all countries periodic industrial and commercial crises, which recur at rather long intervals and immediately react on the activity of traffic. Is this reaction the same on waterways as on railways? We must distinguish between two periods : the boom and the slump.

a) During boom times, shipping hardly increases its normal rate of development of stock and of staff, for any material increase cannot be produced quickly. On the other hand, the amount of work done by the existing stock increases but little; shipowners generally content themselves with profiting by the rise in the rates, which naturally results from the increased demand in presence of a stationary supply, and this rise is only limited by the tariff of the railway.

Then also during boom times the increase of traffic is not appreciably greater than the average increase; matters are quite different with the railway, which is compelled to carry all the additional traffic, even at ruinous expense. It must be added that during industrial booms, the public attaches much more importance to speed, and this also tends to increase the share of the railway. In 1907 a certain number of manufacturers in the east of France went so far as to have metals carried as quick freight.

The phenomenon we are describing may be understood by following the development of traffic on the French railways and waterways during the last thirty years.

DEVELOPMENT OF TRAFFIC.	Slow-freight traffic, in millions of ton-kilometres (in millions of English ton-miles).		
	Railway.	Inland waterway.	Total.
Traffic in 1878	8,400 (5,140)	2,005 (1,326)	10,405 (6,363)
Traffic in 1907	19,890 (12,160)	5,370 (3,280)	25,260 (15,440)
Increase	11,490 (7,030)	3,365 (2,058)	14,855 (9,088)
Total increase, per cent.	137	168	143
Mean annual increase per cent *per year* . .	4·4	5·5	4·6

Taking it altogether, the mean increase of the inland waterway traffic has been slightly greater than that of the railway traffic. Now during these thirty years, the traffic industry has passed through four periods of exceptionally rapid progress :

1878-1883, 1886-1890, 1897-1900 and 1904-1907. We give for each of these periods a table similar to the preceding table :

PERIOD OF BOOM.		Slow-freight traffic (in millions of ton-kilometres [in millions of English ton-miles]).		
		Railways.	Inland waterways.	Total.
1878		8,400 (5,137)	2,005 (1,226)	10,405 (6,363)
1883		11,065 (6,767)	2,383 (1,457)	13,448 (8,224)
Increase from 1878 to 1883	total	2,665 (1,630)	378 (231)	3,043 (1,861)
	per cent.	31	19	29
1886		9,314 (5,696)	2,798 (1,711)	12,112 (7,407)
1890		11,759 (7,191)	3,216 (1,967)	14,975 (9,158)
Increase from 1886 to 1890	total	2,445 (1,495)	418 (256)	2,863 (1,751)
	per cent.	26	15	24
1897		13,791 (8,434)	4,365 (2,669)	18,156 (11,103)
1900		16,557 (10,126)	4,675 (2,859)	21,232 (12,985)
Increase from 1897 to 1900	total	2,766 (1,692)	310 (190)	3,076 (1,882)
	per cent.	20	7	17
1904		16,551 (10,122)	4,968 (3,038)	21,519 (13,160)
1907		19,890 (12,160)	5,371 (3,285)	25,261 (15,445)
Increase from 1904 to 1907	total	3,339 (2,042)	403 (246)	3,742 (2,288)
	per cent.	20	8	17

Thus we find that although lately it has progressed more slowly, the railway traffic has shown much greater increase than waterway traffic at boom times.

It may hence be asserted with absolute certainty that waterways do not take their proportional share when a boom results in a sudden increase of traffic, and that the railway carries nearly all the resulting additional traffic, not only that sent by its own customers but also that sent by the customers of the waterways. It is far from complaining about this, as long as this additional traffic is not too great; as long as the surplus is somewhere near the normal (4·5 per cent per year in France), the railway must be equipped so as to be able to cope with it; it can even meet slightly greater increases, by a more perfect utilization of its stock and by working more briskly. But beyond a certain limit, any sudden increase in the traffic becomes very troublesome.

In particular, during the last boom (1904-1907), the increase on the railway during these three years amounted to 17·4 per cent, a figure not much exceeding the normal ($3 \times 4{\cdot}5 = 13{\cdot}5$ per cent), if the surplus had been divided like the normal increases. As the waterways only took half of their share of the increase (8 per cent), all the surplus came on to the railways. Its total increase thus came

to 20·1 per cent, and a very expensive effort was necessary to meet it, without however escaping the complaints of the public, which does not grasp the situation and often attributes the deficiences of the service only to those of the ways which alone strive to meet the exceptional needs from which the others shrink.

b) It would seem that the inverse phenomenon should be produced during times of slump, shipping being able to lower its rates in order to avoid standing idle, and thus being able to obtain a proportionately greater share of the total traffic.

The traffic industry in France has had two notable times of slump during the period which we are considering. Let us draw up for them a table similar to the last :

PERIOD OF SLUMP.		Slow-freight traffic (in millions of ton-kilometres [in millions of English ton-miles]).		
		Railways.	Inland waterways.	Total traffic.
1883		11,065 (6,767)	2,383 (1,457)	13,448 (8,224)
1886		9,314 (5,696)	2,798 (1,711)	12,112 (7,407)
Increase from 1883 to 1886	total	—1,751(—1,071)	415 (254)	— 1,336 (— 817)
	per cent.	— 16	17	— 10
1900		16,557 (10,126)	4,675 (2,859)	21,232 (12,985)
1902		16,172 (9,890)	4,465 (2,731)	20,637 (12,621)
Increase from 1900 to 1902	total	— 385 (— 235)	— 210 (— 128)	— 595 (—363)
	per cent.	— 2	— 4	— 3

During the first slump, the most serious the railway business has ever known, the railway traffic decreased by 16 per cent, while on the other hand the waterway traffic continued to increase at its normal rate : 17 per cent in three years. It must not be forgotten that that period of slump was precisely coincident with the time during which shipping first benefited by the deepening of the Seine, by the unification of the type of canal resulting from the adoption of the Freycinet plan, and finally by the abolition of tolls, which was decided on in 1880; it was thus natural that it should take an increasing share of the total traffic. But it should be noted that it progressed owing to the advantages bestowed by the public authorities, not owing to the needs of commerce, which were diminishing.

During the 1900-1902 slump, on the contrary, each of the two ways shows a loss at the end of the three years. This loss is but small, but waterways show twice that of railways. It is true that a special cause, the end of the building work carried out on the Seine for the Exhibition, and of its subsequent demolition, resulted at that time in the disappearance of an exceptionally large quantity of traffic.

Thus taking it altogether, it is not evident that during slump times waterways always and necessarily suffer less than railways. A plausible explanation of this can be given. Crises affect above all the large traffic, which gives waterways their

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chief work, and have less influence on the exchange of articles of food and of current consumption, of which railways always carry the chief share. Retail commerce, which only uses the railways, is affected less, or more slowly, by the slump than the wholesale trade, which utilizes the waterways. The normal development of the traffic carried on the railway can thus compensate it, in part at least, and as long as the slump remains moderate, for the reduction in the traffic of the wholesale manufacturers and traders, even if it feels it as much as the waterways, or even more.

XI. — Measures taken by the railways to fight the competition of waterways.

The railway can try to retain, by means of special tariffs, the traffic which the waterway is trying to take away from it. The rates of the latter (except in the case of certain regular services catering for traffic of a special nature and carried by one company or by several companies who have come to an understanding) are chiefly determined by the competition between shipowners. They approximately represent the net cost of the carriage proper, increased in some cases by a slight toll, which as a rule hardly covers the cost of upkeep of the ways. The railway rates, on the other hand, are monopoly rates; to the sum necessary for covering the cost of the carriage proper, there is added an amount, varying with what each consignment can pay, and often rather large, intended to contribute towards the remuneration of the capital expended on the railway. By reducing that part of the rate, the railway can retain traffic it would otherwise lose and thus keep part of the net profit this traffic would yield and which it needs to meet the financial charges weighing on it.

The competition of the railways can thus be direct, when it is for traffic which the waterway can carry from terminal to terminal, or indirect, when it tends to prevent or restrain mixed carriage by measures taken on the railway lines which would form continuations of the waterways.

We will illustrate, by a certain number of examples, the influence which such competition measures have had on the division of the traffic.

A. — *Direct competition.*

Direct competition is the most usual measure adopted by railways, when it is possible. For this purpose it is necessary that freights should not be too low, and moreover, that the railway should be able to reduce its rates sufficiently.

This procedure was formerly very usual in France. We have in fact seen that except on the Seine freight hardly ever falls, in the main directions of the traffic, to below from 1·2 to 1·5 centimes per ton-kilometre (0·188*d*. to 0·235*d*. per English ton-mile). Taking into account the longer distances and the other disadvantages

of the waterways, this freight can hardly compete against a rate of 2 centimes per ton-kilometre (0·314*d*. per English ton-mile) which, as we shall see later on, still leaves a small profit for the railway in case of most of the traffic for which the waterways compete.

The French railways have been restrained, in their reductions of competing rates, by the rules in connection with the authorization of the tariffs. This authorization is given by the Minister of Public Works, on the advice of the consultative railway committee.

For a long time now, according to the doctrine of that committee, a rate for competing with the waterways is not authorized unless it is 20 per cent higher than the corresponding freight. It must be added that the administration no longer admits, except exceptionally, reductions of rates in the form of fixed rates, applying to certain relations only; but generally demands a generalization, in the shape of a scale, applying to the whole system. This would nearly always make the railway lose more in connexion with the traffic it carries in any case, than it could gain from the traffic competed for. Finally, the railway is prevented from trying reductions, the result of which would be doubtful, or for meeting temporary needs, by the practical impossibility of raising its rates again; there has hardly even been an instance a rise of being authorized. The result of this situation in France is that rates which are really competition rates are no longer made. A certain number of reduced rates are however in existence, made formerly with a view to competition. On the other hand, among the new rates authorized, either for general purposes, or in order to extend to an industrial centre, the advantages previously granted to other places, there are occasionally some of a nature to modify the division of important currents of traffic between competing railways and waterways.

We will mention in this connection, as having led to an appreciable increase in the share of the railways, the modification in the coal rates introduced in July 1903 by the common Eastern-Northern tariff No. 107, which gave the results shown in the following table :

Arrivals on the Eastern system.

YEAR.	TOTAL.	BY RAIL.		BY WATER.	
	Tons.	Tons.	Per cent.	Tons.	Per cent.
1901	2,322,000	1,743,000	75	579,000	25
1902	2,283,000	1,726,000	75·6	557,000	24·4
1903	2,736,000	2,052,000	75	684,000	25
1904	2,847,000	2,194,000	77	653,000	23
1905	2,379,000	2,676,000	79·1	703,000	20·9

Similarly we may mention, as regards combined rates, a fixed rate from Rosières, which is in force since 20 April 1898, and which has given the following results :

Traffic to Paris.

YEAR.	TOTAL.	BY RAIL.		BY WATER.	
	Tons.	Tons.	Per cent.	Tons.	Per cent.
1895	26,800	4,800	17·9	22,000	82·1
1896	29,400	3,500	11·9	25,900	88·1
1897	27,400	4,900	17·8	22,500	82·2
1898	31,600	8,800	27·8	22,800	72·2
1899	37,900	15,900	41·9	22,000	58·1

We have stated that railways have above all to fear waterways as regards long-distance traffic. It will accordingly be noted that competition rates are often common rates.

In certain cases, although the effect of certain tariffs has been appreciable it is impossible to prove this by figures, because this effect has been, not to make the railway obtain more traffic, but to consolidate an acquired position; the reduction has only followed the progressive reduction of the freight or met an attempt of a shipping company to take away traffic.

We must look upon the successive reductions in the rates for coal carried from the north to Paris, made by the French Northern Railway, in this light. The progress in the operation of railways has made it possible to realize reductions corresponding nearly to those which the improvement in waterways made in the freights, and the division of the traffic between the two ways has not been materially affected. The share of the railway, which amounted in 1886 to 880,000 tons as against 797,000 tons carried by water, amounted in 1905 to 1,950,000 tons as against 1,620,000 tons carried by water.

We may also mention the reductions in the rates granted to wines in 1894 by the Midi Railway. The reductions made after the replanting of the vineyards which had been destroyed by the phylloxera, in order to enable the wines produced in the south of France to compete in the Paris market, which had during the time of that scourge been entirely captured by Spanish and Italian wines coming by way of Rouen and the Seine, have had the effect of stopping a movement which was beginning to attract to the same way the wines produced in the districts round Cette and Bordeaux, and even to concentrate on these ports, by the Midi canal and the lateral canal of the Garonne, those of the intermediate region.

The fixed rates recently applied to American cotton sent from Channel ports to

the Vosges, have been but an answer to offers made to the spinners by the Havre-Paris-Lyons-Marseilles Company, in order to take the traffic away from the railway.

The most striking instance perhaps is to be found in the considerable reductions the Midi Railway made in the rates on the Bordeaux-Cette line, at the moment when the Midi canal was repurchased in 1898. In order to abolish tolls on the whole of the waterway from Bordeaux to Cette, the government also wanted to repurchase the lateral canal of the Garonne, for which the railway held the concession. This repurchase could not be effected except by agreement with the railway, except indeed in the case of repurchase of the whole system of the latter. The railway only agreed subject to the authorization of a special very reduced tariff, for the most important goods, on its trunk line, which runs alongside the canal the whole way and which would have lost nearly the whole of its traffic if the tolls had been abolished on the canal and the railway had not modified its rates. This reduced tariff, which applies to wine, cereals, sugar, timber, fodder, cement, etc., in truck-loads of at least 5 tons, gives a total rate of 4·50 francs for 100 kilometres (3*s.* 7·5*d.* for 62 miles) and one of 9·75 francs for 400 kilometres (7*s.* 10*d.* for 248 miles, all extra charges included. It has attained its object, for the railway has retained nearly the whole traffic, and that on the canal has hardly increased, in spite of the abolition of the tolls which amounted to several centimes per kilometre. But the Midi Railway estimated the loss of receipts resulting from this reduction at 5 or 6 millions francs (£200,000 to £240,000) per year, at the time the reduction was made; the actual loss, calculated on a rapidly-growing traffic, would be much greater.

Besides these cases, where the share of the railway has been increased or retained as a result of modifications in the tariff, we must mention that of the French Western Railway, which has been ruined by the competition of the Seine, which has taken away all the traffic on its best line, that from Paris to Havre.

It was about 1878 that the work of deepening the water channel between Rouen and Paris to 3 metres (10 feet) was completed. We will not examine whether the reductions to which the railway would have had to agree in order to retain its share of the traffic, would not have been ruinous; that is possible, but not certain, for it would have had to fight against a way technically much superior to the Midi canal, but so tortuous that distances are nearly doubled. But the railway did not, as in the case of the Midi, have rights over part of the waterway, enabling it to make conditions. In order to compete, it would have been necessary to obtain the authorization for very reduced tariffs applying to imported goods, corn, wine, timber, coal (via Dieppe), etc. Protectionist opinion, which never raised any objection to the improvement of the Seine, opposed all attempts to reduce the tariffs which were the consequence of this. After having with difficulty obtained the authorization for some reductions, too small to be effective, the railway had to give up proposing any others and the triumph of the Seine shipping was complete. This can be well

recognized if we compare the traffic, in the two directions together, on the sections where the current of the disputed traffic is not mixed up with any other, namely : 1° on the Seine between Rouen and the the Oise junction ; 2° on the Mantes-Rouen section of the Paris-Havre line.

YEAR.	Mean traffic per kilometre (0 62 mile) (in tons).	
	Seine (from the Oise to Rouen).	Railway (slow-freight) (from Mantes to Rouen).
1881	678,000	1,547,000
1905	2,019,000	1,448,000
1906	2,653,000	1,782,000

It must also be added that the railway benefited in 1906 by an increase in the traffic which is probably not lasting, owing to the want of sufficient shipping to carry the enormous quantity of English coal imported viâ Havre and Rouen after the Courrières accident. If this flow becomes permanent, as seems probable, it is not to be doubted that shipping will in time take all of it.

As regards the tonnage of the consignments forwarded from the two great ports at the ends of the Seine, we have mentioned in chapter IX above (figs. 6, 7 and 8) the results attained by different goods. The annexed diagram fig. 10) gives a summary of the whole state of the up-river traffic, year by year.

Tariffs of direct competition aimed at the waterways are common abroad. We have unfortunately only been able to collect rather limited information as to their peculiarities and as to the results obtained.

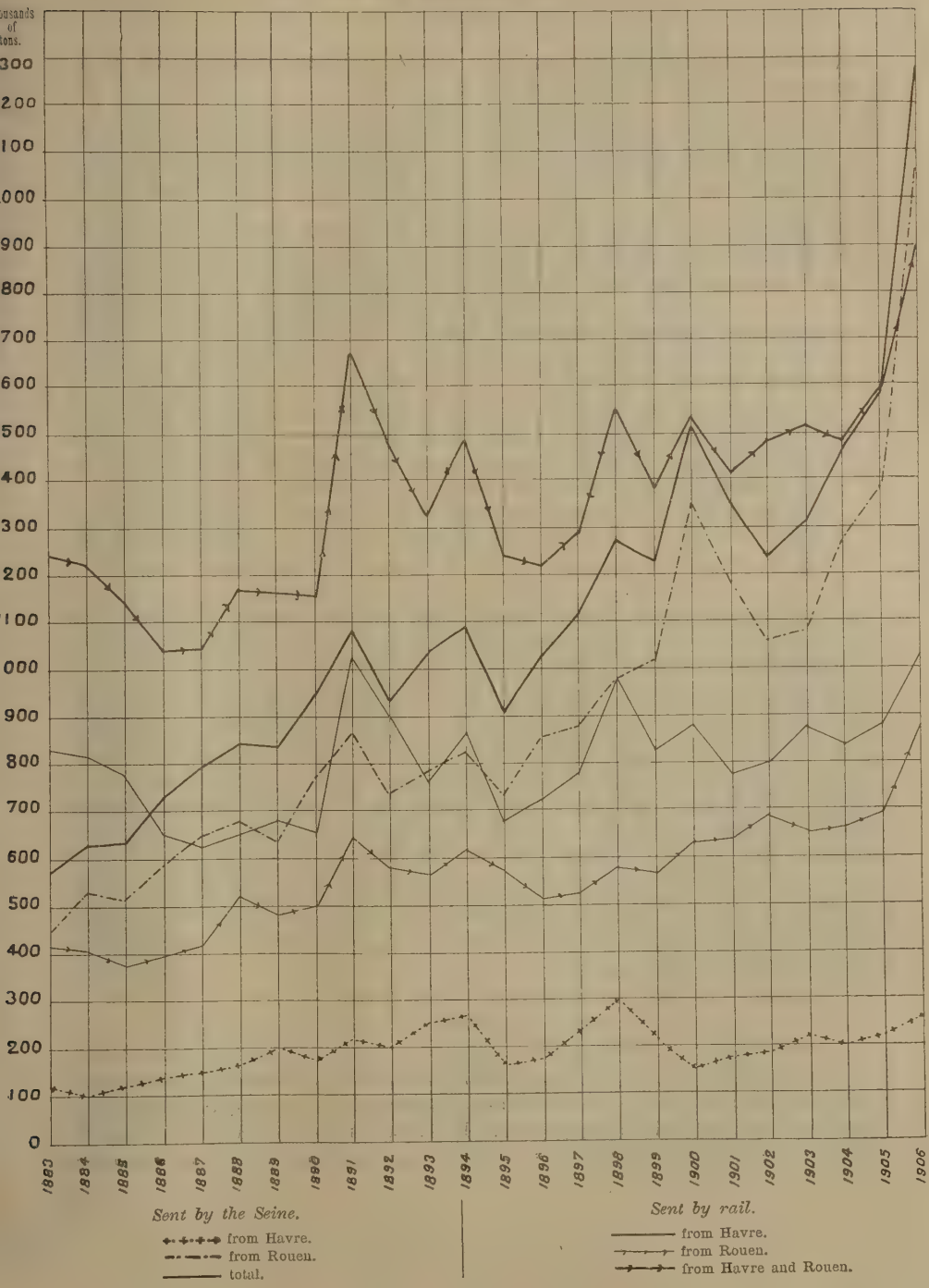
The Austrian State Railway and the Hungarian State Railway inform us of the existence of many reductions in the tariffs caused by the competition of the Danube shipping.

There are in Russia a certain number of competing tariffs, the most important being those which have the object of diverting from the waterways the traffic in soft goods from Moscow to Astrakhan, in candles from Kazan to Moscow, in corn from Astrakhan to Moscow or from the Donetz to the Crimea.

We may state generally that there are two species of competing tariffs which are particularly effective against waterways :

1° In the first place we must mention the tariffs which only apply to large consignors, the best customers of the waterways, without including any corresponding sacrifices in favour of other traders. The Dutch State Railway adopts this system, by making special contracts with the large consignors. The Belgian State Railway

Fig. 10. — Total traffic from Havre and Rouen from 1883 to 1906.



adopts the same system, by applying article 3 of the Royal order of 28 December 1891; we think it of interest to give its text below :

Art. 3. — Exceptional reductions in the rates of the tariffs are granted under the following conditions to all who demand this of Our Ministry of railways, post and telegraphs :

1° That it is proved that at ordinary rates of the tariffs the conveyance would not be effected by rail;

2° That the party benefiting by the reduction accepts conditions of carriage which will make it possible to realize a saving in the working expenses, notably :

a) The regular supply, for carriage, of consignments each of sufficient size to form a complete train-load of at least 150 tons; *b*) the dispatching, on days fixed in advance, of at least one train per week during a minimum period of three months;

3° That the reduction does not have the effect of modifying the conditions of competition between natives of the country.

The maximum amount of the reduction is equal to the difference existing between the rate of the tariff and the cost of the carriage if effected in any other way.

An order of our Minister of railways, post and telegraphs will record that the above conditions are complied with and will fix the amount of the reduction.

In the case of traffic carried under these conditions, the compenation to be paid eventually in the case of loss or damage, such as determined in article 26 of the home tariff of the State, shall be reduced one half

The French railways obtain a simular result, but less complete, by the development of their tariffs applying " from private siding to private siding " in the case of consignments in wagons of 40 tons belonging to the consignors.

2° Another method adopted by certain railways in order to reduce to a strict minimum the loss of receipts resulting from reductions in the rates made necessary by competition, is to suspend their applicatipn during the period when navigation is stopped. Thus during this period the reduced rates of the Hungarian State Railway are raised 10 per cent. This is also done in Russia in the case of many tariffs; for instance the rate for candles from Kazan to Moscow (1,042 kilometres [647 miles]) is 72·82 francs per ton (£2.19*s*. 2·3*d*. per English ton) from 15 October to 15 April and 41·05 francs per ton (£1.13*s*. 4·4*d*. per English ton) from 15 April to 15 October. Similarly certain reduced tariffs are not granted by the Austrian railways except to consignors who guarantee them a certain tonnage while navigation is open.

B. — *Indirect competition.*

On certain rivers, freights are so low that competition is impossible or ruinous for the railway if the conveyance begins and ends on the waterway. This happens on the Volga, the Rhine and the Elbe. But there is always competition possible in the case of *mixed traffic*, that is to say in case the waterway is used for part of

the journey between two points which are not immediately adjoining the waterways.

In that case, the natural policy of the competing railway is to reduce to a minimum the section along the river for which mixed carriage is cheaper than direct railway carriage. It can proceed in two different ways : 1° make a reduced through rate, so as to take the traffic between points the least near to the waterway, and lead to the substitution of railway carriage pure and simple for the mixed carriage; 2° as regards traffic which it is impossible to attract wholly to the railway, combine the rates in such a way as to make the traffic pass from the waterway to the railway at a point such that the rail journey is a maximum.

In France, mixed traffic is rare, although the railways have hardly done anything to avoid it. Freight seldom falls very low, there are but few transhipports, not well situated and not well equipped. All the railways had to do in order not to develop this kind of traffic was not to establish such ports; and they had no obligation to connect their systems with the new transhipports that the State might have established. A recent act (3 December 1908) has just imposed this obligation on them, granting them as compensation a right of indemnity as regards charges and loss of receipts they would incur; under these conditions it is not to be expected that this act will receive many applications.

As against existing transhipports, the railways formerly adopted the making of fixed rates by which the traffic which went wholly by rail benefited, but which were not applicable to mixed traffic. Even when they cannot adopt this procedure, the rapid decrease of the bases of the kilometre rates suffices, in most cases, to make mixed carriage less advantageous than through railway carriage. The development of reduced common tariffs, common to several railways, vigorously demanded by the public in the general interest of long-distance traffic, has naturally had the effect of reducing the use of mixed carriage. We may mention, from this point of view, tariff 114 (west-north-east) for metallurgical produce and tariff 102 (common to all the railway systems) for grains and cereals. The latter, in particular, has brought back wholly to the rails 40,000 tons of barley formerly sent from Beauce to the north by rail to Ivry and thence by boat.

In Russia, direct competition, of which we have already given some instances, is rather rare. It cannot be brought to bear against the Volga, as there are no railway lines along it and as freight is very low there, but only against the waterways of the second order, the lower Dnieper in which there are rapids, the Moskova, and above all the Marie system between the Volga and St. Petersburg. Indirect competition is however much practised under the second form we have mentioned and which consists in keeping the mixed traffic as long as possible on the railway.

If for instance we take the traffic going up the Volga, a reduced tariff will be made in order to divert it as from Kazan or Nijni-Novgorod, if it is going to Moscow, or as from Rybinsk, if it is going to St. Peterburg, and vice versa. We give in a table below the more important tariffs known as " navigation tariffs ". It will be

noted that most of these tariffs, which show reductions of from 20 to 50 per cent as compared with the normal tariffs, are not applicable during the periods when navigation is stopped.

CLASS OF GOODS.	Sent		Distance in kilometres (in miles).	Period of application of reduced tariff.	Rate in francs, per ton (per English ton)	
	from	to			normal.	reduced.
Tallow	Rybinsk.	St. Petersburg.	618 (384)	15 April-15 Nov.	38·09 (£1.10*s.* 11·53*d.*)	14 44 (£0·11*s.* 8·84*d.*)
Canvas	Rybinsk.	St. Petersburg.	618 (384)	15 April-15 Oct.	88·55 (£3.11*s.* 11·72*d.*)	44·10 (£1.15*s.* 10·15*d.*)
Molasses	Rybinsk.	St. Petersburg.	618 (384)	15 April-15 Oct.	33·89 (£1.7*s.* 6·56*d.*)	17·66 (£0.14*s.* 4·26*d.*)
Leather and hides . .	Kazan.	Moscow.	1,042 (647)	15 April-15 Oct.	139·75 (£5.13*s.* 7·13*d.*)	64·00 (£2.12*s.* 0·26*d.*)
Rope and cordage . . .	Rybinsk.	Rostov (Don).	1,598 (993)	15 April-15 Oct.	68·36 (£2.15*s.* 6·79*d.*)	43·42 (£1.15*s.* 3·52*d.*)
Cereals	Rybinsk.	St. Petersburg.	618 (384)	15 March-15 Sept.	24·47 (£0.19*s.* 10·68*d.*)	16·10 (£0.13*s.* 1·01*d.*)
Metallurgical produce .	Rybinsk.	St. Petersburg.	618 (384)	The whole year.	23·54 (£0.19*s.* 1·61*d.*)	14·99 (£0.12*s.* 2·21*d.*)
– – .	Nijni.	St. Petersburg.	1,103 (645)	The whole year.	32·60 (£1.6*s.* 5·98*d.*)	23·04 (£0.18*s.* 8·73*d.*)
– .	Jaroslav.	Moscow.	286 (178)	The whole year.	15·17 (£0.12*s.* 3·97*d.*)	8·45 (£0·6*s.* 10·42*d.*)
Salt	Rybinsk.	St. Petersburg.	618 (384)	The whole year.	22;04 (£0.17*s.* 10·97*d.*)	14·17 (£0·11*s.* 6·22*d.*)
–	Nijni.	Moscow.	427 (265)	The whole year.	17·84 (£0.14*s.* 6·01*d.*)	11·85 (£0.9*s.* 7·59*d.*)

Taking it altogether, the Russian government seems to have followed a very rational policy in not building railways along the first-class river system it possesses, and in trying to attract the traffic to the railways which are connected with these large rivers, as soon as these iron roads make it possible to offer to the public as advantageous a rate for the whole journey, while carrying the traffic as far as possible on their own rails. The railway in fact leaves a certain profit for the remuneration of the capital, after having covered the special costs of the carriage, while all the permanent charges of the waterway fall on the Treasury without direct compensation.

It is in Germany that the mixed traffic has become developed most. It is there that we shall find, apposed to that system of carriage, the most distinct measures of competition and of cooperation. For the moment we will only consider the former. We shall find them in Prussia.

We have already stated how low the freight is on the large German rivers. The

railways cannot attempt any direct competition against them. Indirect competition is on the contrary possible at all the points which do not immediately adjoin rivers, particularly as regards the industrial districts of Westphalia, Bavaria and Silesia. The Prussian railways have hence quite naturally tried to reduce the importance of the mixed traffic, when it is possible to divert it.

The principal method adopted is the establishment of very reduced exceptional tariffs for the seaports. These tariffs are moreover justified by other considerations of national economy; they are intended to favour, according to case, imports or exports, and to support the German seaports as against the foreign ports. But they also have the result, very frequently, of making through carriage by rail more advantageous than mixed carriage which must pay, besides the freight, the insurance and the transhipment, rather high charges for the booking, and a rate for the carriage to the transhipment port, also rather high, for it is calculated on quite another basis than the through rate.

These tariffs have given rise to numerous protests made by the shipowners and a large number of towns which have transhipment ports, such as Mayence, Frankfort, Magdeburg, Breslau. The strongest complaints came from the largest of all these ports, namely from Ruhrort-Duisburg. The latter business town maintains that it also is a seaport, as it makes exchanges with countries beyond the sea by through bills of lading and even by direct navigation; it therefore claims the application of the reduced scales of rates which form the tariffs of seaports, and Magdeburg makes the same claim.

The Prussian railways generally answer with a refusal [1]. We will quote their answer under date of 4 February 1905 to the Chamber of commerce of Magdeburg, on the subject of the reduction of the rates on sugar, and we will reproduce from it a passage which will show the very reasonable doctrine of the Prussian railways on this point:

« ... We have to remind you that modifications in the tariffs, claimed in the interest of the traffic, must not be rejected because they might be injurious to the waterways. Inland navigation, in fixing its freights, has never paid regard to the railway traffic, and the extraordinary progress of inland waterways during the last ten years is largely due to the considerable reduction in the freight, which has attracted to the waterway a considerable portion of the traffic which would otherwise have gone to the railway... There are strong objections to extending in a general way the exceptional tariffs to the transhipment ports. This measure would result in diverting to the waterways part of the railway

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[1] The Prussian railways have exceptionally received these demands favourably, taking care that the reduced tariffs granted to the transhipment ports are never as advantageous as the seaport tariffs. This is the case with certain reductions (which we will refer to later on) granted to Breslau, and with reduced rates granted to Frankfort and Mayence for the carriage of chalks and slates coming from Thuringia, from Saxony and from Bavaria, and which are going to be exported.

traffic. This would assuredly be injurious to the general interests of commerce, for the traders in the immediate neighbourhood of the waterways would then benefit by new reductions in the tariffs: they would be still more favoured as compared with other traders only served by the railway, who already have to bear heavier charges for their traffic. Injured in their conditions of competition, the latter would suffer the consequence of the loss of a large traffic by the railway, which would thus see vanish the possibility of granting the reductions in the tariffs asked for in the general interest of trade. »

It is interesting to show, by a few figures, what has been the result of the indirect competition against this mixed carriage. On the Rhine, this competition makes itself felt very seriously in the case of exports, particularly as regards coal. This is shown by the following statement which gives, for the two years 1886 and 1906, the amount of coal exported from Westphalia to Holland and to Belgium by rail and by water :

	By rail.	*By water.*
In 1886.	1,834,000 tons.	1,831,000 tons.
In 1906.	5,410,000 —	3,349,000 —
Proportional increase	195 per cent.	82 per cent.

The increase has thus been more than twice as great by rail as by water. This is all the more remarkable as during the same period the amount of Westphalia coal sent up-river increased from 1,743,000 tons to 5,446,000 tons, an increase of 212 per cent.

As regards imports, the share of the Rhine is continually increasing, to the detriment of that of the railway; this depends partly on the special advantages which the waterway presents in the case of traffic coming from the seaports, partly on the absence of reduced tariffs for the importation into Germany of produce capable of competing with national produce.

We have already stated (chapter I) that the part played by railways as regards the import of cereals is practically nil. The same applies to timber.

		By rail.	*By water.*
Imports of timber from Holland and Belgium into Westphalia.	1886.	480 tons.	20,000 tons.
	1906.	5,800 —	280,000 —

This phenomenon is still more marked in the case of minerals, although protectionist ideas do not have any influence.

	By rail.	*By water.*
Imports from Holland and Belgium in 1886 . .	240,000 tons.	320,000 tons.
— — — 1892 . .	609,000 —	620,000 —
— — — 1906 . .	37,000 —	2,340,000 —

The inversion which from 1892 substituted a retrogression for the progress hitherto observed in the case of imports by rail, is partly explained by the abolition, in 1893, of the rebates formerly given by the Dutch railways. These rebates had the object of ensuring the utilization, on the return journey, of the wagons used for carrying Westphalian coal which was exported. Seeing the reduction in the freights on the Rhine, which attracted all the coal traffic, the Dutch railways concluded that it was no longer to their advantage to make any efforts to retain a mineral traffic which in itself was hardly remunerative, and this traffic disappeared almost at once.

Taking it altogether, the policy of the Dutch and Prussian railways is not disconnected with the inversion which has taken place in the relative importance of the two currents, of traffic on the Rhine, from the frontier, as shown in the following table :

YEAR.	Traffic	
	down-river.	up-river.
1875	1,772,000 tons.	741,000 tons.
1906	7,690,000 —	13,404,000 —

It does not seem that the competition of the Prussian railways has had any very definite influence on the Elbe traffic, except perhaps as regards sugar for export; the amount conveyed by water, although not diminished in absolute amount, has ceased to progress; it formed 60 per cent of the down-river traffic from Magdeburg in 1897, and only 40 per cent of it in 1906.

This competition appears to be more brisk on the Oder. According to information supplied by the chamber of commerce, the traffic transhipped from wagon to boat at the port of Breslau fell from 1,130,000 tons in 1894 to 629,000 tons in 1905.

Among the articles which have most suffered by this competition, there is in the first place the Silesian coal sent to Pomerania. An exceptional tariff made in order to keep out English coal, made the share of the railway amount in 1906 to 950,000 tons as against 300,000 tons carried by water, while formerly the difference was in favour of the waterways.

In order to utilize empty return wagons, a reduced tariff was made for minerals in connexion with Silesia, so that the share of the railway, in the tonnage of minerals received by Silesia, amounted to 280,000 tons in 1904, as against 86,000 tons by water.

XII. — Collaboration of the railways and the waterways.

We are in the first place going to consider under what conditions collaboration between the railways and the waterways can arise, and then how it is carried out.

A. In what cases is there collaboration? Or rather, in what cases is it to the interest of the railways to organize this collaboration?

We will distinguish between three cases :

1° The railway system in question has its greatest length at right angles to an important waterway. This is the case with the Saxon State Railway, or with the Aussig-Teplitz Railway with respect to the Elbe. This was formerly the case, as regards the lower Rhine, with the three old railway companies (the Rheinische, the Bergisch-Märkische, and the Köln-Mindener) which built the three transhipment ports Hochfeld, Duisburg and Ruhrort, which have become famous since. The same was the case with the old Hessian railway companies. This also applies to many Russian lines ending at the Volga ;

2° The railway system is in the direction continuing the waterway, or rather that part of it accessible to large boats. This is the case which arises on the Baden State Railway, as most of the Rhine navigation ceases at Mannheim. Of the 11,800,000 tons carried in 1906 on this railway, 5,760,000 tons were coming from or going to a Rhine port which in nearly all cases was but a transit point; through Mannheim alone 3,660,000 tons passed, of which 2,255,000 tons (61 per cent) were transhipped direct. The same applies, to a lesser extent, to the Alsace-Lorraine Railway, thanks to the ports of Lauterburg and Strasburg. Similarly the Bavarian State Railway receives quite an important amount of traffic from the upper Danube and will receive still more from the Main when its canalization to Aschaffenburg is completed. The Austrian railways find a feeder of the first order in the Elbe;

3° Another very frequent case is when a railway has an interest in developing its mixed traffic together with a waterway, in order to compete with another waterway or another railway.

The Prussian railways, which are as a rule but little in favour of mixed traffic, know how to make use of it if necessary. Thus they favoured at Schönebeck, on the Elbe, a short distance from the Saxon frontier, the transhipment of the goods which the reduced tariffs applicable when leaving the ports of Riesa and Dresden (1) tend to attract to the Saxon rails. They follow the same policy in order to attract to

(1) During many years the Prussian and the Saxon railways competed with each other in order to bring, by very reduced tariffs, the former to Dresden, the latter to Walwitshafen, also on the Elbe, the

Frankfort part of the traffic which the Baden State Railway attracts to Mannheim. Quite recently even, in consequence of a number of complaints made by the Breslau chamber of commerce, they have granted some reductions in the rates intended to make mixed traffic on the Oder and the Prussian railways possible, in competition with that which the Austrian railways developed on the Elbe, with transhipment at Tetschen.

Similarly the Baden railways looked with an unfavourable eye on the attempts made by Strasburg to develop the navigability of the Rhine above Mannheim. When they saw, in spite of their efforts, the success of the port of Strasburg, they built at Kehl, opposite to Strasburg, a new transhipment port; this port is intended to bring back to the Baden railways the traffic escaping Mannheim, which without that would go to Switzerland by the Alsace-Lorraine railways.

B. How is the collaboration of the two systems of carriage organized in the cases we have just described?

It is effected, on the one hand, by the installation of the transhipment ports which we have already mentioned, on the other, by the establishment of special tariffs which often take the form of transhipment tariffs, that is of tariffs only applying to goods which have come by water or are going to be sent on by water. The customer must then prove the origin or the destination of the goods.

There is a rather large number of such tariffs (*Umschlagstarif*) in Germany and Austria. We will mention some of them :

The Elbe lends itself to the establishment of such transhipment tariffs, at Dresden and Riesa (1) by the Saxon railways, and especially at Tetschen or Laube by the Austrian railways. This makes it possible to obtain very favourable rates for the export of Saxon or Austrian goods via Hamburg, by only having the reduction of the railway journey on a foreign railway.

We will give below, for different articles utilizing these tariffs, a comparison between the through rates by railway alone or by railway and waterway jointly; in the latter case we give two rates, according as hauled boats or quick boats carry the goods on the Elbe. The transhipment charges are 50 centimes per ton (4·9*d.* per English ton), those of the connecting railway 1 franc per ton (9·8*d.* per English ton). The railway rates apply to 10 ton lots. All this information has kindly been supplied by Mr. Schenker.

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beer intended to be exported at Hamburg. This lasted until the two administrations came to an agreement in order to abolish their reduced rates; today everything goes by railway.

(1) The Saxon railways have in some cases granted secret rebates. Some years ago they granted Saxon traders, or traders domiciled in Saxony, rebates of 5 to 20 per cent of the normal tariffs in the case of certain articles (resin, petroleum, etc.), going to or coming from certain places (Munich, Bamberg, Bayreouth), if they transhipped their goods at Riesa or at Dresden. We do not know whether these rebates are always given.

ARTICLES.	Cost of carriage from Vienna to Hamburg (in francs per ton) (per English ton).		
	Slow freight by rail from Vienna to Laube and then hauled boat from Laube to Hamburg.	Slow freight by rail from Vienna to Laube and then by quick boat from Laube to Hamburg.	Slow freight, the whole way by rail.
Lard	30·13 (£1.4*s.* 5·9*d.*)	37·50 (£1.10*s.* 5·8*d.*)	45·63 (£1.17*s.* 1·1*d.*)
Dried hides	40·25 (£1.12*s.* 8·4*d.*)	44·63 (£1.16*s.* 3·3*d.*)	51·87 (£2.2*s.* 1·9*d.*)
Margarine	32·87 (£1.6*s.* 8·6*d.*)	40·00 (£1.12*s.* 6·2*d.*)	58·13 (£2.7*s.* 3*d.*)
Crude copper	28·63 (£1.3*s.* 3·3*d.*)	35·12 (£1.8*s.* 6·6*d.*)	43·00 (£1.14*s.* 11·4*d.*)
Tin	31·62 (£1.5*s.* 8·4*d.*)	38·25 (£1.11*s.* 1·1*d.*)	56·62 (£2.6*s.* 0·3*d.*)
Zinc sheet	30·63 (£1.4*s.* 10·8*d.*)	36·38 (£1.9*s.* 6·9*d.*)	66·50 (£2.14*s.* 0·6*d.*)
Mineral oil	27·88 (£1.2*s.* 7·9*d.*)	34·12 (£1.7*s.* 8·8*d.*)	38·38 (£1.11*s.* 2·4*d.*)
Wrapping paper	23·50 (19*s.* 1·2*d.*)	28·63 (£1.3*s.* 3·3*d.*)	66·50 (£2.14*s.* 0·6*d.*)
Linseed oil	38·12 (£1.10*s.* 11·8*d.*)	43·37 (£1.15*s.* 3*d.*)	43·00 (£1.14*s.* 11·4*d.*)

This great flow of traffic, by which the Elbe benefits, has raised the jealousy of the inhabitants on the banks of the Oder and the Rhine, and the latter have tried, with the help of the German railways who could not but gain by this, to attract part of this traffic. As we have seen above, the Prussian railways, after many complaints made by the Breslau chamber of commerce, granted on 1 April 1907 transhipment tariffs applying to the ports of Breslau, Pöpelwitz and Kosel, for certain articles (particularly copper, wool, cotton, phosphates, saltpetre) sent in transit from German seaports to certain stations in Austria-Hungary. Recent modifications (dated 15 March 1908 and 1 October 1908) have increased the reductions in the rates and the number of stations they apply to. In this way, the Oder and the Prussian State Railway attract a mixed traffic which otherwise would use only the Oder in order to reach the Austrian lines. But the Prussian railways, in order to avoid protectionist complaints, refuse to act similarly as regards the importation into Germany of Austrian or Hungarian goods which actually enter by way of the Elbe.

A similar tariff, but a more important one, has been established by the Austrian, Bavarian, Baden and Prussian railways, with a view to the Rhine. This is the Rhine-Main transhipment tariff (*Rhein-Main-Umschlagstarif*) which applies to goods reconsigned, both export and import, and also gives very low rates. The tranship-

ment ports in question are Mayence, Gustavsburg, and above all Mannheim and Frankfort on the Main. The reduced rates only apply to transit goods passing through Germany, such as cotton, rice, tea, pepper, coffee, articles enumerated in the previous table, etc. The German railways in this way participate in a traffic which would otherwise go to the Elbe alone. The table below gives, for the same articles as the last, a comparison of the rates (in francs per ton) between Antwerp and Bale (transit goods for Switzerland). These rates are based on a Rhine freight of 7·50 francs per ton (6*s*. 1·2*d*. per English ton); the transhipment at Mannheim costs on the average 1·25 francs per ton (1*s*. per English ton). The railway rates, which apply to 10-ton lots, show reductions of 10 to 35 per cent, as compared with the ordinary tariffs.

ARTICLES.	Cost of carriage (in francs per ton) (per English ton) from Antwerp to Bâle, transit.	
	Slow freight, the whole way by rail.	By the Rhine to Mannheim, then slow freight by rail.
Fat	40·5 (£1.12*s*. 11·04*d*.)	29·63 (£1.4*s*. 1·01*d*.)
Hides	35·2 (£1.8*s*. 7·34*d*.)	22·75 (£0.18*s*. 5·90*d*.)
Margarine	40·5 (£1.12*s*. 11·04*d*.)	29·62 (£1.4*s*. 0·92*d*.)
Copper	38·3 (£1.11*s*. 1·58*d*.)	29·63 (£1.4*s*. 1·01*d*.)
Zinc	31·7 (£1.5*s*. 9·20*d*.)	24·87 (£1.0*s*. 2·58*d*.)
Tin	38·3 (£1.11*s*. 1·58*d*.)	29·63 (£1.4*s*. 1·01*d*.)
Mineral oil	35·8 (£1.9*s*. 1·20*d*.)	29·62 (£1.4*s*. 0·92*d*.)
Wrapping paper	38 3 (£1.11*s*. 1·58*d*.)	21·63 (£0.17*s*. 6·98*d*.)
Linseed oil	43·7 (£1.15*s*. 6·25*d*.)	27·62 (£1.2*s*. 5·41*d*.)

The Alsace-Lorraine railways have established transhipment tariffs at Lauterburg and at Strasburg in order to get their share of this traffic, principally for relations with Switzerland. The rates are more favourable to Lauterburg, so as to give the longest possible journey to the railway. The chief reductions affect coal, petroleum and colonial provisions.

There are also some transhipment tariffs established by the Bavarian railways at Passau and at Ratisbon, on the Danube; the most favourable rates apply to Passau, which is the port nearest the Austrian frontier and hence leaves the longest possible journey to the Bavarian railways.

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We find even more complete cases of collaboration between railways and waterways, when the carriage involves two transhipments.

We may mention the tariff applied by the German lines for diverting from the Elbe or possibly from Triest the traffic coming from Austria and going to oversea countries. This tariff, known as the Danube-Rhine-Main transhipment tariff (*Donau-Rhein-Main-Umschlagstarif*), covers two transhipments : the first, from the Danube to the railway at Ratisbon (or Passau), the second, from the railway to the Rhine or to the Main at Mannheim or at Frankfort. We give below a comparison of the cost of carriage of the same goods as before, between Antwerp and Vienna, according to whether the railway alone is used, or one or two transhipments also. This information, due to the courtesy of Mr. Schenker, is established on the basis of a freight of 7·50 to 8·75 francs per ton (6*s*. 1·2*d*. to 7*s*. 1 35*d*. per English ton) on the Rhine from Antwerp to Frankfort; a tranship rate of 1·60 francs per ton (1*s*. 3·6*d*. per English ton) and a rate for the connecting railway in the same port of 3·75, 2·50 or 1·25 francs (3*s*., 2*s*. or 1*s*.) per wagon according to the class of goods. The freight on the Danube (Ratisbon-Vienna) is taken at 10·25 francs per ton (8*s*. 3·98 *d*. per English ton); the tranship rate at Ratisbon is taken at 0·85 franc per ton (8·29*d*. per English ton) and the connecting rate at Ratisbon at 0·375 franc per ton (3·66*d*. per English ton).

ARTICLES.	Cost of carriage (in francs per ton) (per English ton) from Antwerp to Vienna.		
	Slow freight the whole way by rail.	From Antwerp to Frankfort by water, from Frankfort to Vienna as slow freight by rail.	From Antwerp to Frankfort by water, from Frankfort to Ratisbon as slow freight by rail, from Ratisbon to Vienna by water.
Fat	47·60 (£1.18*s*. 8·29*d*.)	42·50 (£1.14*s*. 6·55*d*.)	39·00 (£1.11*s*. 8·41*d*.)
Hides	54·30 (£1.16*s*. 5·66*d*.)	44·87 (£1.16*s*. 5·66*d*.)	38·25 (£1.11*s*. 1·09*d*.)
Margarine	70·80 (£2.17*s*. 6·59*d*.)	47·75 (£1.18*s*. 9·76*d*.)	40·50 (£1.12*s*. 11·04*d*.)
Copper	63·90 (£2.11*s*. 11·28*d*.)	36·25 (£1.9*s*. 5·58*d*.)	34·00 (£1.7*s*. 7·64*d*.)
Zinc	60·10 (£2.9*s*. 0·22*d*.)	37 50 (£1.10*s*. 5·78*d*.)	35·12 (£1.8*s*. 6·56*d*.)
Tin	67·00 (£2.14*s*. 5·52*d*.)	36·25 (£1.9*s*. 5·58*d*.)	34·00 (£1.7*s*. 7·64*d*.)
Mineral oil	70·80 (£2.17*s*. 6·59*d*.)	37·75 (£1.10*s*. 8·22*d*.)	38·38 (£1.11*s*. 2·36*d*.)
Wrapping paper	40·80 (£1.13*s*. 1·97*d*.)	39·13 (£1.11*s*. 9·68*d*.)	35·75 (£1.9*s*. 0·71*d*.)
Linseed oil	70·80 (£2.17*s*. 6·59*d*.)	50·75 (£2.1*s*. 3·02*d*.)	41·38 (£1.13*s*. 7·62*d*.)

All the transhipment tariffs which we have just considered are tariffs of *origin* or of *destination*, which end at the waterway. The consignor must himself attend to arranging the freight for the carriage on the water. This freight varies; the comparisons of the cost of carriage, from terminal to terminal, are only based on averages. In fact the total mixed carriage is not effected at a fixed rate, and it gives rise to the making of two transport contracts. There is another class of mixed traffic which is of an opposite character, and where there are actually *combined tariffs or tariffs common to the railways and the shipping enterprises.*

These tariffs, which are brought before our notice by the Hungarian State Railway, the Austrian State Railway, the Bavarian State Railway and the Austrian Southern Railway, only apply to the Danube; this explains itself, for this river presents this exceptional character that nearly the whole traffic on it is in the hands of two companies who can make lasting agreements with the railways and carry them out : these are the Austrian and the South German Danube navigation companies. The former deals with the Austrian and the Hungarian railways, the latter with the Bavarian railways. In both cases, the share (of the total rate) received by the navigation company is fixed in advance.

The combined tariffs with the Austrian and the Hungarian railways take into consideration a large number of routes to south Germany or to the Balkans and apply to a large number of goods, particularly to paper and to metallurgical produce.

The combined rates for the Danube and the Bavarian railways apply, up-river, to cereals, flour and oil seed going to Switzerland or south Germany. Down-river, the rates distinguish between destinations in Austria-Hungaria and destinations in the countries further down the Danube (Servia, Rumania, Bulgaria), for which the reductions in the rates are much more marked. It is in fact the traffic of these districts, which could very easily take quite a different route by going to the Black Sea.

We see that all cases of collaborations between railways and waterways are, with hardly an exception, cases of competition against another route.

THIRD PART.

Comparison of the net cost of carriage by rail and water.

I. — Utility of this comparison and method of making it.

We have tried to consider the conditions under which the traffic actually divides itself between the railway and the waterway, the influence exercised on this division by the different circumstances which occur in practice and the lines of conduct adopted by the governments or administrations concerned.

Our work would not be complete if, taking the above question, we did not try to show in what cases the one or the other way is superior from the point of view of the net cost of the carriage. Whenever any service which is essential to the public prosperity can be performed by two different agencies, apart from the particular interests which may be concerned in the one or in the other, there is from the point of view of the common wealth, one general interest : the service must be organised so as to result in the least expenditure possible, for the same satisfaction of given needs. If it were proved that in any given case, for any given kind of transport, one of the two means, the railway or the waterway, involves definitely less expenditure than the other, this would of itself prove that any organization leading to the use of the latter, rather than the former, would result in a clear loss. Such a proof would no doubt not suffice for settling all the questions involved in the policy to be adopted as regards ways of communication; but it would in any case be of considerable weight in discussing them.

We will not attempt to solve this question in a general way. As regards broken-load traffic (and we mean here by the word " broken-load " consignments of which a certain number are necessary for making up a complete train-load or a barge-load), the question would be both nearly insoluble and also not of much interest.

The question would be insoluble, for such traffic can only be carried by large undertakings, organizing regular services and having permanent installations at all the places they serve. These undertakings, utilizing one and the same staff and one and the same plant for consignments which are absolutely heterogeneous, would be quite unable to determine, out of their total expenditure, how much of it referred to each operation. What settles the rate they ask for any individual transport, is not its estimated net cost, but the estimated sum which it is possible and equitable to ask it to contribute towards the total expenditure which has to be covered.

The question would on the other hand be of no interest, for no one disputes that the railway is far better suited to this kind of traffic than the waterway, owing to the

variety and regularity of its services, owing to its aptitude to branch off so as to reach all parts of the territory, owing to the possibility of making up trains of wagons coming from everywhere and going to anywhere. No doubt at certain points shipping enterprises can be organized which can prosper by taking away from the railway some of its broken-load traffic; but it is never with a view to these services that it is proposed to construct or extend waterways, and their organization is but a subsidiary consequence of works carried out for a totally different object.

This object is the conveyance of goods in large masses, coming from or going to seaports, industrial centres and lage towns between which there are exceptionally busy currents of traffic. It is when one of these currents is not properly served that the question arises whether a waterway or a railway is better for improving the situation. It is accordingly for this kind of traffic that it is advisable to draw up a comparison of the net cost of these two ways.

In order to find the net cost of carriage proper on water, it is enough if we determine the mean freight charged for whole boat-loads, deducting the tolls if any. Under the influence of the competition between the different enterprises, large and small, which cater for that traffic, the freight necessarily approximates to the net cost. Enterprise and experience confirms in this respect what reasoning enables us to foresee. All the analyses which have been made of the elements of the net cost of water carriage under these conditions show that the freight fluctuates near the total of these elements (1), so that the annual gain of the boatman who works on his own account represents on the average fairly accurately, the pay of a workman of the same class, plus the interest and amortization of the cost of his boat. The inequalities which we have mentioned in the average level of the freights, according to district and to article, correspond to the inequalities in the net cost. These themselves result from the different conditions under which the boats work from the points of view of the cost of traction, the utilization of the staff and of the stock, etc.

On the railway, the net cost of carriage is no longer equal to the rate; it only forms the lowest limit to which it may be the railway's interest to lower the rate, rather than lose the traffic. We have said that it would be very difficult to fix this limit with accuracy for each element of a whole number of traffics including infinite varieties. But we may form a sufficiently-approximate idea for the special kind of traffic we are considering here, for that which presents itself in lots sufficiently large to have a specialized staff and stock devoted to it, so that the consignments consist, if not of whole train-loads, at least of an important number of truck-loads starting from one given station and going to another given station.

It should in the first place be noted that with this class of traffic, the loading and

(1) See more especially Mr. Plichon's rapport on the projected canal to the north of France; Chambre des Députés, 7th session, No. 2995.

the unloading of the wagons is carried out by the consignors and the consignees, just as is always the case with complete boat-loads. On the other hand, the only railways where waterway competition has to be taken into consideration are those which follow valleys or pass from one valley to another over ground sufficiently level to make it possible to run a canal across the watershed; under these conditions, railway main lines are never built with gradients exceeding 3 to 5 per mil. We can accordingly limit our examination to the case of a service not including any handling, and operated on lines with such an excellent profile.

In this examination we will successively assume two very distinct hypotheses :

1° We will in the first place consider the ordinary case, that in which the two ways between which competition can arise already exist. Assuming that it is a question of railway which already carries passengers, parcels and smaller lots of goods, we will try to take separately the traffic we are considering, in order to determine its net cost. We will compare this with the cost of similar traffic carried on a waterway.

2° We will take the case when the existing lines have arrived at the limit of their capacity and when this cannot be increased without excessive expense, on account of the difficulties which arise from the industrial development of a district and from the multiplicity of adjoining works which would render any extension ruinous. The traffic would then make necessary the construction of a new line of great capacity and built wholly for the specialized traffic we are considering; we will then try to determine what would be the cost of a new railway, on the one hand, and of a new canal, on the other.

II. — Case where traffic uses existing lines.

Taking as our basis the working conditions of the French railway systems on which heavy traffic plays a great part, we will try to estimate within what limits the net cost of this special traffic varies.

It is comparatively easy to obtain an absolute minimum by calculating what it costs the railway to run an *extra* train. We mean by extra train one which can be added to the trains already running on the line, without any alteration in the general organization of the services, without the company having to incur any expense for supplementary works, for cost of general management, for the maintenance of the way and works, for station staff. The cost then only includes the cost of the train proper.

According to the results observed on several railways and the information we have received from the heads of the departments concerned, we think we can estimate, with sufficient accuracy, the cost per train-kilometre of an extra train

weiging 1,000 tons gross, consisting of 20-ton wagons and carrying a paying load of 700 tons, running on a line with a very good profile, at a time when coal is at its average price, as follows :

Expenses special to the train (locomotive men and train men, fuel, repairs of locomotives, etc.) .	1·55 francs (1*s.* 11·95*d.* per train-mile).
Interest and maintenance of rolling stock . . .	0·90 franc (1*s.* 1·90*d.* — —).
Total. . .	2·45 francs (3*s.* 1·85*d.* per train-mile).

If we assume that the train runs back empty, the cost per kilometre (per mile) for the return falls to 2·15 francs (2*s.* 9·22*d.*), owing to the reduction in the weight hauled. The journey out and home thus costs 4·60 francs per useful kilometre (5*s.* 11·07*d.* per useful mile) or $\frac{4.60 \text{ francs}}{700} = 0{\cdot}65$ centime per ton-kilometre (0·102*d.* per English ton-mile).

Among these investigations into the net cost made at our request, we would mention a very complete one made by the French Eastern Raiway; we reproduce the essential parts of it in an appendix. The interesting feature of this work is that it leaves as little as possible to hypothesis, being based on a service which actually exists. The data concerning the organization of the time-table, the importance and the utilization of the staff and of the rolling stock, accordingly leave no room for criticism. We may add that they take into account all the elements which in practice reduce that utilization (interruption of the traffic in consequence of the application of the law of the weekly rest; rest and leave of absence of employees; repairing and cleaning the rolling stock, etc.). In its work, the French Eastern Railway has considered two instances of the carriage of minerals, the one between Hussigny or Homécourt and Lourches, 284 kilometres 176 miles), the other between Moutiers and Differdange, 83 kilometres (52 miles). Assuming that the service is stopped one day out of six in order to allow for Sundays and feast days, a net cost of 0·49 centime per ton-kilometre (0·077*d.* per English ton-mile) is obtained in the first case, and one of 0·73 centime per ton-kilometre (0·115*d.* per English ton-mile) in the second; the average in thus 0·62 centime (0·097*d.*) a figure which nearly approximates that of 0·65 centime (0·102*d.*) given above.

It is evident that this cost is never realized unless it is question, not of an occasional addition to the traffic, but of a *regular and important* traffic. Such traffic naturally involves an increase in the expenses not specialized, which must be allowed for. It is impossible to estimate the increase accurately, but an idea of it may be formed from the relative importance of the expenses concerned.

We will take from the French railway statistics for 1907 the net cost per train-kilometre on the two systems the Northern and the Eastern, which are those on

which the traffic we are considering has most importance. These means are calculated for the whole of services, both passenger and goods.

DEPARTMENT.	French Northern.	French Eastern.
General management	0·22 franc (3·399*d.*)	0 21 franc (3·244*d.*)
Traffic	0·75 — (11·587*d.*)	0·87 — (1*s.* 1·441*d.*)
Rolling stock and locomotive	1·06 francs (1*s.* 4·376*d.*)	0·81 — (1*s.* 0·514*d.*)
Way and works	0 36 franc (5·562*d.*)	0·41 — (6·334*d.*)
Miscellaneous	0·02 — (0·309*d.*)	0·06 — (0·927*d.*)
Total. . .	2·41 francs (3*s.* 1·233*d.*).	2·36 francs (3*s.* 0·460*d.*)

The estimate of the expenses *special* to a complete train of heavy goods, which we have given above, is much greater than the *mean* cost to the *rolling stock and locomotive department*, per train-kilometre, given above; two circumstances explain this : 1° a train much heavier than the mean train is considered; 2° the figures first given include the train men, who are charged for under the traffic department, while the rolling stock and locomotive department only pays for the drivers and firemen and the staff at the locomotive sheds.

As regards the *traffic* department, we would on the contrary only have to reckon with expenses much below the mean, in the case of the special traffic which we are considering. The principal expenses, in fact, which the statistics include under this head are :

The staff which does the secretarial work at departure and at arrival, delivers tickets, checks the consignments, works out the rates; this work, which is very expensive and complicated in the case of a broken-load or a passenger train, hardly represents anything in the case of a train consisting of identical consignments which are very few in number.

The handling is in this case done by the parties concerned.

The sorting, marshalling and making-up operations at the start, en route, and on arrival, are in this case practically nil as the train runs from terminal to terminal and as the sets of wagons are often got ready on private sidings.

As regards the train conductors and guards, we have already allowed for them in the figure of 2·45 francs (3*s.* 1·85*d.* per train-mile) previously given as the expenses special to the train considered.

We therefore think we will be much above the truth if we add to the last figure, for the traffic expenses which do not figure there, one third of the mean expenses, per train-kilometre, corresponding to the operations included under the heading of traffic for the whole of the system.

As regards management and miscellaneous expenses, we will take the mean without modification. By taking, in the case of traffic not involving any complication, its proportional part in the expenses (which include the payments towards the pensions of all the traffic staff, although this traffic hardly affects it), we shall be above the truth rather than below.

We will do the same as regards the cost of way and works. A heavy train wears the line more than a light one; but the deterioration of the roadbed and of the track itself depends on other factors besides the importance of the traffic, and in any case, the corresponding expenses are far from increasing in the same proportion; they contain a fixed part which, divided for each line by the number of trains, gives a quotient which is the lower the greater the traffic. It is thus probable that the extra cost of maintenance of a busy line resulting from the passage of a heavy train exceeds the mean cost of maintenance of the system, referred to the mean train-kilometre (train-mile). Moreover, the traffic which we are considering hardly makes any use of any of the buildings. Hence we shall thus allow for this item very fully if we take half of the figure given in the statistics.

By adding together all these different items, we thus find :

On the French Northern. . . .	85 centimes per train-kilometre	(1*s.* 1·13*d.* per train-mile).
On the French Eastern	97 —	—	(1*s.* 2·98*d.* —).

Dividing the supplementary expenditure so calculated for 2 train-kilometres (1·24 train-mile) (there and back) by 700, we find we have to add 0·24 centime (0·038*d.*) in the case of the French Northern and 0·28 centime (0·044*d.*) in that of the French Eastern, to the figure of 0·65 centime per ton-kilometre (0·102*d.* per English ton-mile).

A third element has still to be take into consideration : the cost of supplementary works (enlarging stations, duplicating tracks, etc.) made necessary by the growth in the traffic.

Let us compare, for the purpose, the progress of the traffic, and the expenditure made on supplementary works on the French Northern and Eastern systems during the last twenty years. We find :

	French Northern.	*French Eastern.*
Increase in the slow-freight traffic, from 1888 to 1907 inclusive (in thousands of ton-kilometres) (in thousands of English ton-miles).	1,926 (1,178)	1,830 (1,119)
Increase in the passenger traffic from 1888 to 1907 inclusive (in thousands of passenger-kilometres) (in thousands of passenger-miles)	1,456 (905)	1,120 (696)
Expenditure on supplementary works, from 1 January 1888 to 31 December 1907 (in millions of francs)	207 (£8,280,000)	134 (£5,360,000)

In the absence of anything to guide us, let us assume that the expenditure on supplementary works is divided between the two services (passengers and slow freight) proportionately to the new kilometre units, and that the traffic we are considering takes its proportional part. This seems a rather large allowance, for even if the development of this heavy traffic has necessitated considerable expenditure, particularly on the construction and extension of yards and shunting and sorting sidings, this expenditure per kilometre unit is certainly less than that due to the development of the passenger traffic. Near great towns, particularly in the case of Paris, the suburban service has developed very quickly, making extensive and very costly work necessary for extending the large stations and their approaches. The very short mean distance travelled by the suburban passengers makes these expenses enormous, if referred to the passenger-kilometre (1). If then we assume that the expenditure on supplementary works is the same per passenger-kilometre as per ton-kilometre, we probably obtain too high a figure for the latter kind of traffic.

It may be noted, on the other hand, that we make no deductions for those supplementary works which are only for the quick-freight traffic, the cattle traffic, etc., traffic which brings in 10 per cent of the receipts and which has developed particularly quickly during the last twenty years. The positive error, in calculating the fraction of the expenditure due to each kilometre unit of the additional traffic, which results from this omission, more than counterbalances the negative error we incur in not deducting from the total increase in the number of kilometre units the part due to the new lines opened during the last twenty years. This deduction would in fact be very small, as the new lines are not extensive and are but little used on the systems which we are considering; the most numerous and the most important, in that district, are those which have been constructed exclusively for strategic purposes and which have hardly contributed to the development of the traffic.

Two exceptions have however to be made. On the French Northern, additional lines are at present being built, intended to relieve the main lines, from the great coal basin to Paris; but none of these were yet open to traffic in 1907, so that they in no way helped to carry the traffic in that year. On the French Eastern, several new lines have been built in the last few years in order to develop the Briey basin; the expenditure incurred for the purpose really corresponds to a new and important traffic. We will accordingly add the total expenditure on these lines to the account for supplementary works on the French Eastern, namely 34 million francs (£1,360,000), remarking however that this expenditure will make it possible to deal with a large traffic which as yet is only beginning to develop. This addition increases the expenditure in supplementary works, on the French Eastern Railway,

(1) The mean distance per passenger, in 1906, was 26 kilometres (16 miles) on the French Northern and 28 kilometres (17 miles) on the French Eastern.

incurred to deal with the growth of the traffic from 1887 to 1907, from 134 to 168 million francs (£5,360,000 to £6,720,000).

The annual charges corresponding to the supplementary works of this period, calculated at the rate of 4 per cent for interest and amortization, then represent :

On the Northern	8,280,000 francs	(£331,200)
On the Eastern	6,720,000 —	(£268,800)

Divided by the number of additional kilometre units of traffic, this gives for each additional kilometre unit :

On the Northern	0.24 centime	(0·038*d.* per English ton-mile)
On the Eastern	0·26 —	(0·041*d.* — —)

By adding, in the case of each railway, to the estimate of the special expenditure caused by running a heavy train of the modern type, the two other elements which enter into the net cost per kilometre (per English ton-mile), we obtain :

On the Northern	0·65 + 0·24 + 0·24 = 1·13 centimes	(0·177*d.*)
On the Eastern	0·65 + 0·28 + 0·26 = 1·19 —	(0·187*d.*)

No doubt, these figures are not obtained from an exact division of the total expenditure between the different kinds of traffic, which is practically impossible; a similar analysis, carried out on other lines, would no doubt give other results. The explanations we have given however show that the estimate we have arrived at errs on the positive rather than on the negative side.

It may thus be finally asserted that the net cost of carrying a ton of coal or mineral 1 kilometre, on railway lines competing with waterways, when consignments of a number of truck-loads, of an importance comparable with barge-loads, are dealt with, will not exceed from 1·10 to 1 20 centimes (0·173*d.* to 0·188*d.* per English ton-mile).

If we assume that on the return journey a sum would be earned only equal to one fifth of that earned on the out journey, this maximum would fall to between 0·90 and 1 centime per ton-kilometre (0·141*d.* and 0·157*d.* per English ton-mile).

This rate is materially higher than the freight paid for similar traffic on the great European free-running rivers, the Volga, the Rhine, the Elbe. It is approximately equal to the normal freight paid on the Seine and on the best canals on the north and the east of France. It is distinctly lower than the freight on the rivers which form waterways of the second order from the point of view of their technical qualities. But it must be noted that we have included, in the case of railways, every kind of expenditure. On the other hand, apart from certain exceptions exceedingly rare in France, the freight includes nothing for the cost of management and maintenance of the line, nothing for the cost of supplementary works, the duplicating of

locks, etc., which any material increase in the traffic will make necessary. It may hence be asserted that the total expenditure required for carrying the same amount of traffic is in France nearly always less if a railway is used than if a waterway is used. Even assuming that the latter already exists and that it can carry the traffic competed for without any increase in the cost of construction and maintenance which falls on the State, and that on the contrary, on the railway, the traffic causes an increase in the cost of maintenance and of supplementary works, there will generally be a slight economy in adopting the latter; as soon as any supplementary expenditure has to be incurred in the case of waterways, the difference becomes very appreciable.

It follows from this that wherever the two ways coexist, the railway should attract, without suffering any loss, the traffic which goes to the waterway, by offering equally low rates, with all the advantage of regularity and speed, and that there would result, for the whole of the common wealth, a material saving in the amount spent in carrying the traffic. It must however be remarked that such low rates could not be normally admitted as the bases of the tariffs. It is in fact necessary that the railways should remunerate their construction capital out of their receipts, and if, in order to obtain traffic which they might miss, they can content themselves in the case of that traffic with a small or even infinitesimal profit, they could not carry in the same way, at very near cost price, the millions of tons capable of contributing to a greater or less extent towards the payment of the permanent charges on the railway system, unless the State placed the burden of paying the interest and amortization on the tax-payers, as it nearly always has done in the case of waterways. In order therefore to make it really possible for a railway to take away the traffic competed for from the waterway, it must be able to grant reduced rates applying to this traffic alone. It will in all cases find great difficulty in doing so; in France, in particular, such reductions would not be authorized, for they would seem, and with some reason, to benefit to an excessive extent the manufacturers concerned. The privilege which public opinion grants unconcernedly when it takes the form of advantages granted to waterways, would raise its reprobation if it resulted from railway rates; the public would very soon require that the reduced rates should be made general, assuming that the authorities would have authorized them to be applied to certain lines only. The administrations which operate the railway must consequently, when they are competing with waterways, take into consideration in their calculations the reaction exercised by any reduction in the tariffs on the traffic which is not competed for.

Finally we may remark that in comparing waterway and railway rates there is another element, continually becoming more and more important, which is generally left out of consideration; namely the legal protection of the railway employees. Even if we leave this protection out of consideration, the railway employees are already much better remunerated than the waterway employees; it is natural that the former, who often have delicate and very responsible work to do, should earn in

a year a good deal more than the latter, sometimes two or three times as much. The railway administrations are led to pay these salaries or wages, without any intervention of the public authorities, because they represent the value of the work done; that is a normal element of the net cost, and one can only congratulate oneself on having a large number of workers well paid and well treated. But on the other hand, all the measures of regulation or legal protection affecting railway employees (the tenth day's work rest of drivers and firemen, the limitation of the of work per day, the fixing of a maximum age giving a right to a pension, the fixing of a minimum rate for that pension, etc.) artificially augment the cost of carriage on railways as compared with that on waterways, as, in France at least, there is nothing of the sort in the case of watermen. Without discussing to what extent these measures are justified or not, we have to state they are continually taking a far greater development, capable of modifying, to the disadvantage of the railway, the comparison of the net cost which we have just made. Nobody disputes that it would be impossible to burden the water traffic with the extra charges necessary for benefiting the watermen to the same extent, and that this would kill the water traffic. But it must be noted that it would be considerably to the advantage, not only of the taxpayers called upon to pay the charges not covered by the tolls, but also to that of the working classes, that it should be the railway, rather than the waterway, that developped its traffic and consequently its staff.

III. — Case where it is necessary to make a new way on account of the development of heavy traffic.

Let us now assume that the lines which could be utilized have arrived at the limit of their capacity, or do not present the technical conditions necessary for a heavy traffic. It is then necessary to make a new line, either a railway or a canal. In practice, if a railway is built, it is utilized not only for the traffic which could go on a canal, but also for passenger and quick freight traffic. If this is done, it is evident that this solution is more advantageous than if a line is built and used for heavy traffic only; but this procedure makes it difficult to compare the railway and the waterway, because an instrument intended for a very complex service, other things being equal, is necessarily more expensive than an instrument only intended for a very simple service.

In order to establish a useful comparison, we will assume that a railway has been built for heavy traffic only and that it conveys neither parcels nor passengers. Such cases exist in America (for instance, the line from Pittsburg to Lake Erie), but there is hardly an instance of any importance in Europe. It is however such an instance which has to be examined, if we want to ascertain whether it is a railway or a canal which can carry, under the most economical conditions, the excess of heavy traffic existing lines can no longer deal with.

In the absence of any practical instance, we have requested the French Northern

Railway to calculate the net cost of carriage of coal from the north to Paris, assuming the traffic concentrated on a specialized line, and not carrying any traffic in the opposite direction. We reproduce its answer in an appendix.

This answer is of considerable value, for on the one hand, the operating and traction expenses are based on the results of experience; and on the other, the calculation of the capital outlay necessary is based on the figures of the Picardy-Flanders line, where the traffic was insignificant until a recent period when the administration decided to equip it in order to divert on to it a very large coal traffic, so that it is only necesary to deduct the cost of buildings from the total expenditure on building and improving the line in order to obtain a very accurate estimate of the cost of a line specialzed for heavy traffic.

As in all investigations of this kind, it is possible to criticize some of the figures. It may be asked whether the total time admitted for the round trip (two days) is not rather short, as on the existing railway this takes at least three days, including the stop at the mine. The assumption of an end-to-end traffic, without junctions or crossings, is evidently favourable to the railway. On the other hand, it must be noted that in a comparison with a waterway, it was not necessary to assume that the railway should be equipped so as to be able to cope with the maximum traffic which arises at certain seasons : the waterway is not compelled the cope with exceptional demands, for it adjusts the irregularities of its traffic by putting off what it cannot take, and, in the case of the railway, an assumption of nearly regular traffic would have resulted in a great saving in rolling stock. On the other hand, the calculation has been made for the traffic which at present exists, namely, for 3 million tons of coal; now all that part of the expenditure relating to the construction of the line would suffice, without increase, for a considerable development of the traffic. Taking all this into consideration, we think that we can accept the figure of 1 centime per ton-kilometre (0·157*d*. per English ton-mile), which the Northern Railway arrives at (see appendix II), as very near the truth with the existing traffic, and capable of very appreciable reduction as the traffic increased.

It is interesting to compare this result with that arrived at in a recent work, entitled *Massen-Güterbahnen*, by Messrs. Rathenau and Cauer (Julius Springer, Berlin 1909) (1). The object of the authors was to investigate what would be the normal cost per ton-kilometre on a standard-gauge railway line, connecting the Ruhr basin and Berlin, and replacing the « Mittelland » canal, in part voted in 1905. This railway would only have gradients of 2 per mil, curves with radii of 3,000 metres (150 chains), no level crossings, and a station at every 55 kilometres (34 miles). The cost of construction would be 500,000 francs per kilometre (£32,186 per mile). As soon as opened, this line would carry a traffic of 10 million tons, one fifth of this being in the return direction. The traffic would be so distributed that at the busiest time of the year it would be 50 per cent greater than at the slackest. The authors

(1) See *Bulletin of the Railway Congress*, No. of January, 1910, p. 518.

assume that this traffic, brought to the stations from private sidings, would be conveyed by trains with a paying load of 1,600 tons, carried in 40-ton wagons, at a speed of 30 kilometres (18·6 miles) per hour. The block-system would have to be installed

This investigation, which is also based on applying to a particular instance the results of general experience and practice, differs from the instance previously given in the fact that it does not assume a uniform end-to-end traffic. The net cost varies naturally with the distances taken, as shown in the following table :

Cost of carriage per ton-kilometre (per English ton-mile) at a distance of.	500 kilom. (310 miles) on the average :	0·91 centime	(0 143*d.*)
	390 — (242 —) —	0·97 —	(0·152*d.*)
	280 (174)	1·10 centimes	(0·173*d.*)
	170 — (106 —) —	1·37 —	(0 215*d.*)

These figures are absolutely comparable with those given by the French Northern Railway. It is interesting to observe this agreement. It should be added that the comparison we have just made only applies to a new line, built for carrying a very heavy tonnage. Hence it can only be applied in a very few cases, for instance the "Mittelland" canal of Germany, the "Nord" canal of France and the "Nord-Est" canal of France.

We see that even taking cost of construction into account, the total net cost of carriage by rail remains comparable with the freight on the best existing canals and on ordinary rivers, this freight being taken by itself, no allowance being made for the capital expenditure as well as for the cost of maintenance and management of the waterway.

But in practice, unless in the case of a free-running river where a large surface of water supplies a way of indefinite capacity, it may be assumed that where railways are overloaded, the waterways are so also. The question which then arises is whether it is better to duplicate the railway or the canal (this is the case of the "Nord" canal in France), or whether it is better to duplicate an overloaded railway or build a canal in a direction when none as yet exists, as Germany is now doing.

A canal can then be built accessible to boats taking from 600 to 700 tons; mechanical traction can be reduced to 0·6 or 0·7 centime (0·094*d.* or 0·110*d.* per English ton-mile), which compares with the outlay of the rolling stock and locomotive department on the railway; these are the rates which it is hoped to obtain on the German canals recently decided on. But these canals, in spite of the easy ground, are estimated to cost over 600,000 francs per kilometre (£38,620 per mile). The new "Nord" canal to Paris, through more irregular country, was originally estimated to cost the same amount, although only built for 300-ton boats. It is already certain that this estimate will be largely exceeded in both cases.

Nobody on the other hand will maintain that from the point of view of capacity for traffic, a canal is superior to a railway on which only trains used for one and the same service run, and on which the movement of the slow-freight trains will

never be interrupted in order to allow a passenger train to pass. The capital charges, *per ton of capacity*, will thus incontestably be greater in the case of a canal than in that of a railway used only for one and the same kind of traffic.

It is interesting to find that taking it altogether the estimates made by the French Northern Railway and by Messrs. Rathenau and Cauer, for the case of a new line, are quite of the same order of magnitude, as those which we arrived at in the case of traffic adding itself to that on an existing line, used for railway traffic of all kinds. In both cases we find that the cost on the railway, interest on new works included, is lower rather than higher than the freight charged on all the canals opened up till now, which does not include cost of construction. It is no doubt hoped in the case of the new canals that freight may be obtained approximately equal to the cost incurred by the rolling stock and locomotive department in the case of heavy traffic on railways; but those hopes are not yet realized, and in any case the difference of capacity of lines constructed at an equal cost would leave the advantage to the railways, assuming naturally that the traffic to be carried will one day become sufficiently large to utilize that great capacity.

Thus if all expenses are included, it certainly seems that even in the case of heavy traffic which shipping claims as peculiarly its own, the railway remains the most economic carrying instrument, in all the places where nature has not provided large rivers with a gentle fall.

In the different preceding comparisons, we have only considered the cost per kilometre. We have not taken into account the savings resulting from the fact that the railway is generally shorter, and from the facilities afforded by its numerous branches to distribute without transhipment throughout the whole district the goods brought on its main line. Even if we leave these elements out of consideration, which are of considerable importance, one is right in thinking that under normal conditions the railway is the economical way, while it is at the same time the quick and the regular way. If the opposite opinion is widely held, it is due to the fact, generally forgotten, that the railway rates nearly always include the remuneration of the capital stock, while in the case of waterways, this is nearly always left to the taxpayers.

APPENDIX I.

Summary of an investigation made by the French Eastern Railway into the net cost, per train-kilometre, of a train weighing 1,000 tons gross, carrying a regular heavy-goods traffic on a line with a good profile.

We have requested the proper departments of the French Eastern Railway to make this investigation, taking as their basis as nearly as possible an actually-existing service and adopting, for the different elements of the expenditure, the classification of table 19bis of the French railway statistics, which corresponds to the following articles in table XIII of the report to the meeting of the shareholders of the French Eastern Railway Company.

Classification of table No. of the French railway service. (*19bis (old form)*; *35 (new form)*)	*Corresponding articles in table XIII of the report to the meeting of the shareholders.*
Staff (including the premium for saving fuel). . . .	Art. 1. — Central administration (staff). Art. 3. — District administration (staff). Art. 5. — Traction (staff).
Fuel consumed by the locomotives.	Art. 6. — Traction (fuel for the locomotives).
Maintenance of the locomotives, carriages and wagons (including handling)	Art. 9. — Stock (upkeep of locomotives and tenders). Art. 10. — Stock (upkeep of carriages and wagons).
Sundry expenses	Art. 2. — Central administration (office expenses and miscellaneous) Art. 4. — District administration (office expenses and miscellaneous). Art. 7. — Traction (lubrication, lighting, water, sand and miscellaneous articles of consumption). Art. 8. — Traction (miscellaneous "general expenses of the sheds, upkeep, renewal of tools and appliances, heating, lighting, etc."). Art. 11. — Renewal of rolling stock.

In order to have more precise information, we requested the company to replace article 11 of the report by the direct calculation of the interest and amortization of the material, assuming the rate of interest to be 4 per cent and the amortization to take forty years in the case of locomotives and fifty years in that of wagons. We assumed the train weighing 1,000 tons gross to consist of 20-ton wagons, which, with the Eastern rolling stock, corresponds to a paying load of 680 tons. We requested that to these expenses there should be added the cost of train staff (belonging to the traffic department). All the French regulations on the safety and the composition of trains, and on the rests of the employees, were to be taken into consideration. The calculations were to be based on the average price paid for coal and for rolling stock. Finally, it was to be assumed that the train was to run back empty.

The French Eastern answered our request in the most complete way, by investi-

gating the net cost of the two existing services for the carriage of minerals, one between Hussigny or Homécourt and Lourches (284 kilometres [176 miles]), the other between Moutiers and Differdange (83 kilometres [52 miles]).

We reproduce the first of these two investigations *in full :*

Service of trains carrying minerals between Hussigny or Homécourt and Lourches, a distance of 284 kilometres (176 miles).

(Two trains of 1,000 tons per day.)

For hauling these trains 9·2 locomotives and 9·2 locomotive crews are required. — The locomotives are of type 4,000, with four coupled wheels, compound, with four cylinders. — The number of these locomotives has to be increased by 25 per cent for reserves, unavailabilities and repairs.

The locomotive staff, 9·2 crews, has to be increased by 10 per cent for leaves and illnesses.

The rolling stock consists of four sets of wagons. — The wagons are 20-ton wagons and each set consists of 34 wagons and 1 van. — The number of these wagons has to be increased by 10 per cent for repairs, examinations and immobilizations.

IMPORTANT NOTE. — The list of expenses given below does not include the expenses of the traffic and the way departments (except for the train men, added at the end).

Among the rolling stock and traction expenses, there are not included the following items : contributions of the company to pension and provident funds; general expenses of the central administration of the company; assistance, contributions towards family expenses, etc. ; medical service; interest on the stores ; upkeep of buildings ; interest and amortization of buildings; interest and amortization of the tools and appliances at the workshops and sheds; taxes of all kinds; fire insurance; accident insurance; contribution of 7·50 per cent of the fixed salaries towards the insurance funds of the company's employees.

Determination of the cost of a service of trains for carrying minerals between Hussigny or Homécourt and Lourches (284 kilometres [176 miles]).

		Cost	
		total annual.	per kilometre (per mile) of loaded train.
Service.	Two trains per day : 2 × 284 (176) = 568 (352) loaded trains.		
	1 × 284 (176) = 284 (176) empty trains.		
	1 × 284 (176) = 284 (176) locomotives running light.		
	1,136 (704) (total distance run by locomotives).		
	Annual distance run :		
	Loaded trains . 568 (352) = 207,320 (128,825)		
	Empty trains. . 284 (176) × 365 days = 103,660 (64,412.5) = 414,640 km. (257,650 miles.)		
	Locomotives running light . . 284 (176) = 103,660 (64,412.5)		

			Cost	
			total annual.	per kilometre (per mile) of loaded train.
	Expenditure :		Francs.	Francs.
	Art. 1. — Central services : Cost per kilometre in 1908 . . 0·01017 fr. / Art. 3. — District services : Cost per kilometre in 1903 . . 0·00436 fr.	0·01453 fr. × 414,640 km. = 6,024·71 fr.		
	(Cost per kilometre, trains loaded : 0·02906 fr.)			
	§ 3 of article 5. — Traction (drivers and firemen) :			
	Mean cost of a crew : Pay . . . . . 3,639·18 fr. / Allowances . . . . . 521·17 fr. / Premiums (not including fuel premiums). . 980·01 fr.	4,160·35 fr.		
		5,140·36 fr.		
	Fuel premiums . . . . . 995·12 fr. $\left(1 + \frac{50}{100}\right)$ =	1,492·68 fr.		
		6,633·04 fr.		
	Number of crews . . : 9·2 $\left(1 + \frac{1}{10}\right)$ = 10·12 × 6,633·04 fr. = . . .	67,126·36 fr.		
	(Cost per kilometre, trains loaded : 0·32378 fr.)			
Staff.	§ 1 of article 5. — Traction (chiefs of depots and their assistants) : Net expenditure in 1908. . . . . 511,547·14 fr.		88,825·07 (£3,553)	0·42844 (6·6192*d.*)
	§ 2 of article 5. — Traction (employees of depots) : Net expenditure in 1908. . . . . 332,857·47 fr.			
	§ 4 of article 5. — Traction (men at depots : examiners, shunters, cleaners, men lighting fires, etc.) : Net expenditure in 1908. . . . . 1,293,790·78 fr.			
	Total. . . 2,138,195·39 fr.			
	referred to the net expenditure (drivers and firemen) of the year 1908, this gives $\frac{2,138,195·39 \text{ fr.}}{9,156,008·90 \text{ fr.}} \times 100 = 23·35$ per cent, to be applied to the figure of 67,126·36 francs given above, whence : $\frac{67,126·36 \text{ fr.} \times 23·35}{100}$ = ...	15,674·00 fr.		
	(Cost per kilometre of loaded trains : 0·07560 fr.)			
	Total. . .	88,825·07 fr.		
	referred to the distance run by loaded trains, this gives $\frac{88,825·07 \text{ fr.}}{207,320 \text{ km.}} = 0·42844$ fr.			
	Carry forward. . .		88,825·07 (£3,553)	0·42844 (6·6192*d.*)

	Cost	
	total annual.	per kilometre (per mile) of loaded train.
	Francs.	Francs.
Brought forward. . .	88,825·07 (£3,553)	0·42844 (6·6192*d.*)
Fuel for locomotives. Consumption per kilometre: 25 kg. × 414,640 km. = 10,366 tons, including { briquettes (40 p. c.) . 4,146 tons. small coal (60 p. c.) . 6,220 —		
Average price in 1908 of ton of fuel, loaded on tender. . . . . { briquettes . . . . 26·917 francs. small coal . . . . 21·122 —		
Mean price . . . . { 26·917 fr. × 4,146 t. = 111,597·88 fr. 21·122 fr. × 6,220 t. = 131,378·84 fr. } $\frac{242,976·72 \text{ fr.}}{10,366 \text{ t.}} = 23·44$ fr.	242,976·72 (£9,719.1*s.* 4·32*d.*)	1·17199 (1*s.* 6·1066*d.*)
Total expenditure . . . . . 111,597·88 fr. + 131,378·84 fr. = 242,976·72 fr.		
referred to the distance run by loaded trains, this gives $\frac{242,976·72 \text{ fr.}}{207,320 \text{ km.}} = 1.17199$ fr.		
Upkeep. 1° Locomotives and tenders (number of locomotives : 11·5).		
Art. 9. — Upkeep and repair of locomotives and tenders (including tools and appliances for lighting up) :		
This expenditure rose in 1908 to 5,609,532·01 francs. or a cost per train-kilometre (per train-mile) on the Eastern of $\frac{5,609,532·01 \text{ fr.}}{55,532.700 \text{ km.}} = 0·10101$ fr.,		
to be applied to the total mileage proposed (414,640 kilometres) (257,·50 miles), whence 0·10101 fr. × 414,640 km. . . . . 41,882·79 fr.		
Increase of 15 per cent due to the type of the locomotives : $\frac{41,882·79 \times 15}{100} =$ 6,282·42 fr.		
Total. . . 48,165·21 fr.		
referred to the distance run by loaded trains, this gives : $\frac{48,165·21 \text{ fr.}}{207,320 \text{ km.}} = 0·23232$ fr.		
2° 20 ton wagons.	73,421·21 (£2,936.16*s.* 11·62*d.*)	0·35414 (5·4713*d.*)
Each set consists of 34 wagons and 1 van, so that with 4 sets. . . . . : 35 w. × 4 = 140 wagons.		
Increase of one tenth for repairs, inspection and immobilization . . . . . 14 —		
Total. . . 154 wagons.		
Annual upkeep per wagon. { 150 fr. for the wagon. 14 fr. for the two pairs of wheels.		
Total. . . 164 fr.,		
or, for 154 wagons, a total expense of. . . . : 164 fr. × 154 w. = 25,256·00 fr.		
referred to the distance run by loaded trains, this gives $\frac{25,256 \text{ fr.}}{207,320 \text{ km.}} = 0.12182$ fr.		
Carry forward. . .	405,223·00 (£16,208.18*s.* 4·32*d.*)	1·95457 (2*s.* 6·1970*d.*)

		Cost.	
		total annual.	per kilometre (per mile) of loaded train.
		Francs.	Francs.
	Brought forward. . .	405,223·00 (£16,208.18s. 4·82d.)	1·95457 (2s. 6·1970d.)
Miscellaneous expenses.	Art. 2. — Central services (official expenses and miscellaneous) : Cost per kilometre in 1908 . . 0·00149 fr.		
	Art. 4. — District services (office expenses and miscellaneous) : Cost per kilometre in 1908 . . 0·00098 fr.		
	Art. 7. — Traction (lubrication, lighting, water, etc.) : Cost per kilometre in 1908 . . 0·02363 fr. — 0·03592 fr. × 414,640 km. = 14,893·87 fr.	14,893·87 (£595.15s. 1·15d.)	0·07184 (1·1099d.)
	Art. 8. — Traction (heating, lighting, upkeep and renewal of tools and appliances at the depots) : Cost per kilometre in 1908 . . 0·00982 fr.		
	referred to the distance run by loaded trains, this gives $\frac{14,893·87 \text{ fr.}}{207,320 \text{ km.}} = 0·07184$ fr.		
Interest and amortization.	1° Locomotives and tenders.		
	Number of locomotives . . . . . $9·2\left(1+\frac{1}{4}\right) = 11·50$		
	Average weight of a locomotive, type 4000 . . . . . 67,473 kilograms.		
	Average weight of a tender holding 13 cubic metres (2,860 English gallons) . . . . . 14,905 —		
	Average price of a locomotive. . . . . 1·85 fr. × 67,473 kg. = 125,000 francs.		
	Average price of a tender . . . . . 1·00 fr. × 14,905 kg. = 15,000 —		
	Together (locomotive plus tender). . . 140,000 francs.		
	Total value of locomotives and tenders required : 140,000 fr. × 11·5 = 1,610,000 fr.		
	Interest and amortization in forty years, at 4 per cent (4·00 fr. + 1·0523) = 5·0523 fr. p. c.		
	or altogether. . . . . $\frac{1,610,000 \text{ fr.} \times 5·0523}{100} = 81,342·03$ fr.	118,722·03 (£4,748.17s. 7·40d.)	0·57265 (8·8471d.)
	referred to the distance run by loaded trains, this gives. . . $\frac{81,342·03 \text{ fr.}}{207,320 \text{ km.}} = 0·39235$ fr.		
	2° Wagons.		
	Cost of a set (35 wagons) . . . . . 182,500 fr.		
	Increase of one tenth for repairs, inspection and immobilization 18,250 fr. — 200,750 fr.		
	this gives for four sets. . . . . 200,750 fr. × 4 = 803,000 fr.		
	Interest and amortization in fifty years, at 4 per cent (4·00 fr. + 0·655) = 4·655 fr. p. c.		
	whence an expenditure of . . . . . $\frac{803,000 \text{ fr.} \times 4·655}{100} = 37,380$ fr.		
	referred to the distance run by loaded trains, this gives . . $\frac{37,380 \text{ fr.}}{207,320 \text{ km.}} = 0·18030$ fr.		
Train staff.	8 chief conductors at 2,600 francs = ... 20,800 fr.		
	29 brakesmen at 2,100 francs = ... 60,900 fr.		
	Total expenses . . . 81,700 fr.	81,700·00 (£3,268)	0·39408 (6·0883d.)
	referred to the distance run by loaded trains, this gives . . $\frac{81,700 \text{ fr.}}{207,320 \text{ km.}} = 0·39408$ fr.		
	Total. . .	620,538·90 (£24,821.11s. 1·44d.)	2·99314 (3s. 10·2423d.)

The second investigation is made, on exactly the same plan, in the case of traffic between Moutiers and Differdange (83 kilometres [52 miles]); it results in a cost of 4·33 francs per useful train-kilometre (5*s.* 6·90*d.* per train-mile). It is at once clear, if the two services are compared, what influence the length of the journey exercises on the net cost of the traffic, and to what extent the marked reduction in the rate per kilometre in the case of longer distances is justified. The reduction in the net cost when the distance increases is easily explained by the better utilization of the staff and of the rolling stock. The difference is shown in the following table :

ANNUAL DISTANCE RUN (in kilometres [in miles]).	*First instance* (284 kilometres [176 miles]).	*Second instance* (83 kilometres [52 miles]).
Of each locomotive	36,055 (22,404)	17,626 (10,952)
— set of wagons	103,660 (64,413)	60,590 (37,650)
— locomotive crew	40,972 (25,459)	20,029 (12,446)
— train man	51,830 (32,206)	30,295 (18,825)

The net costs given above have been calculated on the assumption that the service is kept up without interruption on the three hundred and sixty-five days of the year. The company remarks that in reality such a service would hardly be operated on more than three hundred working days; hence it is necessary to reduce the annual distance run by the trains by one sixth, without any serious saving resulting except in fuel.

By introducing these two corrections, we obtain, for a year of three hundred days :

—	*First instance* (284 kilometres [176 miles]).	*Second instance* (83 kilometres [52 miles]).
Annual distance run by loaded trains, in kilom. (in miles)	172,767 (107,354)	50,492 (31,375)
— cost, in francs (in £)	579,842 (300,304)	251,722 (156,416)
— cost, per kilometre (per mile) of loaded trains, in francs	3 36 (4*s.* 3·910*d.*)	4·98 (6*s.* 4·938*d.*)

If we divide the cost per useful train-kilometre by the number of tons hauled (680), we obtain the net cost per ton-kilometre (per English ton-mile):

In the first case	0·494 centime	(0·078*d.*)
In the second case	0·732 —	(0·115*d.*)
Average	0·613 —	(0·096*d.*)

APPENDIX II.

Note by the French Northern Railway on the net cost of carrying coal on a line specially built for the purpose, capital charges included.

The assumption made is as follows :

All the consignments of coal and coke going from the coal yards in the Pas-de-Calais department to Paris (La Chapelle, La Plaine, Saint-Ouen, Champ-de-Mars, Clichy-Batignolles, locomotive coal included) and to the places beyond Paris to the other systems, via Bourget and La Chapelle, are supposed to be concentrated at Lens; the total tonnage, according to the 1907 figures, being in round figures 3 million tons.

This traffic is supposed to go from Lens to Paris (La Chapelle) via Corbehem (by Lens-Brebières), Montdidier (Picardy-Flanders) and Ormoy, the total distance being 260 kilometres (162 miles).

The examination of the expenses comes under the heads of capital outlay, working expenses and annual charges of the capital.

The round figure of 267,000 francs per kilometre (£17,187 per mile) may be adopted as the cost of construction of the line; this is approximately what the Picardy-Flanders line cost, after deduction of cost of buildings and of sidings at stations, but including the cost of the duplication which is now being carried out. The two terminal stations (Lens and La Chapelle in Paris), may be estimated, including the buildings, the sorting sidings and the appliances, at 600,000 francs (£24,000) in the case of Lens and 2,400,000 francs (£96,000) in that of La Chapelle, or 3 million francs (£120,000) the two.

Assuming the line to be equipped with a semaphore at every 5 kilometres (3 miles), the 260 kilometres (162 miles) require 52 semaphores costing 8,000 francs (£320) each (disks, semaphores and signal cabins included), or 416,000 francs (£16,640) altogether.

We may assume that three locomotive depots are required, two larger ones at the two terminals and one at the middle of the distance, including the necessary sidings, workshops, sleeping quarters and buildings for the staff: these will cost on the average 500,000 francs (£20,000) each, or 1,500,000 francs (£60,000) for the lot.

The Picardy-Flanders line, after the present works and rectifications have been carried out, will make it possible to haul 900 tons by means of locomotives of the type 6,000. Assuming the paying load to be 600 tons, 3 million tons per year would correspond to a traffic of $\frac{3,000,000}{365}$ tons per day, if the traffic were uniform throughout the year. But actually the experience acquired on the French Northern Railway shows that it is necessary to be so equipped as to make it possible to deal on some days with $\frac{1}{220}$ of the annual traffic. Consequently it is necessary to be equipped for $\frac{3,000,000}{220} = 13,636$ tons, or say 23 trains, each with a paying load of 600 tons, per day.

About 50 locomotives costing 115,500 francs (£4,620) each are required for this traffic;

total 5,775,000 francs (£231,000). The stock necessary is represented by 1,500 tip wagons, taking 20 tons each; 200 of these must be fitted with brakes. These cost :

1,300 tip wagons at 3,796 francs (£151.17*s.*). . .	4,934,000 francs	(£197,360)
200 — at 4,368 — (£174.14*s.*). . .	873,600 —	(£34,944)
50 vans at 8,282 — (£331.6*s.*) . . .	414,100 —	(£16,564)

The capital outlay accordingly sums up as follows :

Line	69,420,000 francs	(£2,776,800)
Terminal stations	3,000,000 —	(£120,000)
Signals	416,000 —	(£16,640)
Depots and workshops.	1,500,000 —	(£60,000)
50 locomotives	5,775,000 —	(£231,000)
1,300 tip wagons, 20 tons.	4,934,000 —	(£197,360)
200 — 20 tons with brake . . .	873,600 —	(£34,944)
50 vans	414,100 —	(£16,564)
Total. . .	86,332,700 francs	(£3,449,308)

WORKING EXPENSES.

Upkeep.

Upkeep of the line, 1 per cent of cost of construction. . . .	694,200 francs	(£27,768)
— — stations, 2 per cent of cost of construction . .	60,000 —	(£2,400)
— — signalling system, 2 per cent	8,320 —	(£332.16*s.*)
— — depots, 2 per cent.	30,000 —	(£1,200)
— — locomotives and rolling stock, at 40 centimes for 1,315,600 train-kilometres (3·84*d.* for 817,490 train-miles), loaded, and at 20 centimes for 1,315,600 train-kilometres (1·92*d.* for 817,490 train-miles), empty.	789,360 —	(£31,574.8*s.*)
Lighting and heating the stations (taking the annual expenses of two equivalent stations on the Northern system) . . .	79,660 —	(£3,186.8*s.*)

Cost of staff.

Central staff.	20,000 francs	(£8,000).
The station staff may be estimated by taking for the station-masters and assistant station-masters that part of the general service at Lens station dealing with the coal traffic, namely 46,680 francs (£1,867.4*s.*), and assuming that the lower-grade employees include one chief inspector, one chief switchman, four pointsmen, five gangs, two foremen; per station; this, at the average pay of such men on the French Northern, comes to 65,626 francs (£2,625) per station, or for the two stations	131,252 —	(£5,250.2*s.*)
104 signalmen at 1,266 francs (£50.13*s.*) each, for the 52 signal cabins.	131,664 —	(£5,266.8*s.*)

Train staff.

The train staff consists of :

60 chief-conductors	at 2,650 francs (£106)	159,000 francs	(£6,360)
60 brakesmen	at 2,026 — (£81.1*s.*). . . .	121,560 —	(£4,862.8*s.*)
60 drivers	at 3,880 — (£155.4*s.*) . . .	232,800 —	(£9,312)
60 firemen	at 2,520 — (£100.16*s.*). . .	151,200 —	(£6,048)
	Total. . .	664,560 francs	(£26,582.8*s.*)

Cost of traction.

The cost of traction may be estimated at 33 centimes per kilometre (5·871*d.* per mile) of loaded train and at 18 centimes per kilometre (2·781*d.* per mile) of empty train; total for 1,315,600 train-kilometres (817,490 train-miles) loaded and 1,315,600 train-kilometres (817,490 train-miles) empty . . . . . 736,736 francs (£29,469.9*s.*)

The cost of lubrication at 2 centimes per kilometre (0·309*d.* per mile) amounts to. . . . . 26,312 — (£1,052.10*s.*)

The working expenses thus sum up as follows :

Upkeep of line.	694,200 francs	(£27,768)
— of stations	60,000 —	(£2,400)
— of signalling system.	8,320 —	(£332.16*s.*)
— of depots	30,000 —	(£1,200)
— of locomotives and rolling stock. . . .	789,360 —	(£31,574.8*s.*)
Lighting and heating stations	79,660 —	(£3,186.8*s.*)
Central staff.	20,000 — (1)	(£800)
Station staff.	131,252 —	(£5,250.2*s.*)
Signalling staff.	131,664 —	(£5,266.11*s.*)
Train staff	664,560 —	(£26,582.8*s.*)
Cost of traction.	736,436 —	(£29,457.9*s.*)
Cost of lubrication.	26,312 —	(£1,052.10*s.*)
Total. . .	3,371,764 francs	(£134,870.11*s.*)
To this must be added 9 per cent of the pay of the staff, contributed by the company to the pension fund, namely	85,992 francs	(£3,439.14*s.*)
Total working expenses, pensions included . . .	3,457,756 francs	(£138,310.5*s.*)

(1) The cost of staff for lighting and heating the stations is included (for 6,000 francs [£240]) in the ,660 francs (£3,186.8*s.*) given above for the heating and the lighting of the stations.

*

Capital charges.

Assuming that the capital of. . . . . 86,332,700 francs (£3,453,308)
is to be amortized in fifty years, the annual chages corresponding to that capital, assuming a rate of interest of
4 per cent, is. . . . . 4,018.787 — (£160,751.10*s.*)
In this case, the total annual charges amount to. . . 7,476,543 — (£299.061.14*s.*)

The net cost, on these assumptions, then amounts to $\frac{7,476,543}{3,000,000} = 2{\cdot}492$ francs per ton (2*s.* 0·31*d.* per English ton), and to $\frac{2{\cdot}492 \text{ francs}}{260 \text{ kilometres}} = 0{\cdot}0096$ franc per ton-kilometre (0·151*d.* per English ton-mile).

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SECTIONAL DISCUSSION

Meeting held on 5 July 1910 (morning).

MR. EVELYN CECIL, VICE-PRESIDENT, IN THE CHAIR.

Mr. Colson. (In French.) — As I am a reporter on the first question which we are going to discuss, I have requested Mr. Cecil, vice-president, kindly to take the chair at this meeting.

The President. (In French.) — I call upon Mr. Louis Marlio, reporter for all countries except America and Great Britain, to give a summary of the report drawn up jointly by him and by Mr. Colson.

Mr. Louis Marlio, *reporter.* (In French.) — In the report which Mr. Colson and I have drawn up, relating to the question of the influence of waterways, considered as feeders and as competitors, on railways, we have divided our statements into three sections :

The first section contains a short review of the countries, England and the United States excepted, where navigation is of importance. In this review, we examine the administrative regime affecting railways and waterways, the importance of the traffic and the cost of carriage by rail and by water.

In the second section, which is the most important one, we consider the different factors which influence the distribution of the traffic between the railways and the waterways.

Finally, in the third section, we try to determine, from information given by many writers, by a method, approximating as nearly as possible to actual practice and based on actual results, the net cost of carriage as compared with that on waterways.

I will give a short summary of these three sections.

In the first place, we have examined the situation on the railways and the waterways in different countries, namely in Russia, Germany, Austria, Hungary, France, Belgium and Holland.

I will at once state that the report was written two years ago; the figures we give are accordingly somewhat old now, particularly those concerning the net profits of railways, which have materially diminished for the last two years in all the countries of the world.

Hence, we must go back two years in order that the statements in the report

*

may be considered as in agreement with truth.

Without entering into the details of this first section, I will give some very striking figures in order to show in what countries a comparison of the relations between railways and waterways may be of most interest.

In the first place, we must mention Russia, for it is in that country where water carriage is of most importance, both from the absolute and from the relative points of view.

From the absolute point of view, the waterway traffic amounted to 35 milliard ton-kilometres (21,404,889,000 English ton-miles). I may here mention that by a printer's error the figure is given as 35 millions, while it should be 35 milliards on page 31 of the report (1).

What is curious is that the ton-mileage of the railways is the same as that of the waterways, and that the growth of the railway traffic is absolutely paralleled by that of the waterway traffic.

After Russia, and leaving out of consideration England and the United States, the country where navigation is of most importance is Germany, where the traffic on waterways amounted in 1905 to 15 milliard ton-kilometres (9,173,524,000 English ton-miles), as against one of 45 milliard ton-kilometres (27,520,571,000 English ton-miles) on railways.

The third place is occupied by France, where the waterway traffic is 5 milliard ton-kilometres (3,057,841,000 English ton-miles), as against a railway traffic of 19 to 20 milliard ton-kilometres (11,619,797,000 to 12,231,365,000 English ton-miles).

As regards the administrative regime of waterways and railways, I will at once draw your attention to the importance of the direct or indirect subventions given to the waterways by the different States.

Generally speaking, while railways have been built by companies, the different governments have as a rule been far more generous towards the waterways which have been constructed at the State's expense.

The principle now accepted in the case of waterways is that of free gift; that is to say, that the capital expended on the construction of waterways is sunk, without return.

We have, however, noted a few exceptions; in France, we can mention the case of the city of Paris, the Marne-Saône canal, where certain tolls are levied. I may add that the yield of these tolls only represents a very small fraction of the capital charges.

In Germany, the principle of charging tolls is more general than in France; it is the ordinary principle on canals and on canalized rivers, such as the Main; it was the principle which was adopted when the 1905 programme was voted, in the case of all the free rivers; but this principle is not yet applied owing to international difficulties which arise in connection with the introduction of tolls on the two great rivers, the Rhine and the Elbe.

The remark we have just made is essential to the question, for in comparing rates, we must remember that railway tariffs always include a fraction towards the maintenance of the line and the amortization of the capital, while this is not the usual practice in the case of waterways.

(1) See *Bulletin of the Railway Congress*, number of March, 1910, p. 1127.

In the second part of our report, we have tried to ascertain and determine as accurately as possible the importance of the different factors which may in one way or another influence the distribution of traffic between railways and waterways.

Before entering into details, we have to remark that waterways, owing to their very position, cannot compete, in all directions, with railways.

On the other hand, it must not be forgotten than waterways can also not compete with railways for all kinds of traffic; passenger traffic and quick-freight traffic must be excepted.

Among the factors which influence the distribution of the traffic, the most important is *the cost of carriage*.

It is self-evident that when we talk of comparing the cost of carriage, we must compare things that are really comparable, and only compare with the freight charged by ships, the railway rates, applicable to goods sent under the same conditions, for instance by train-loads, and when the handling is at the cost of the consignor or the consignee.

Generally, we find that the cost of carriage by water is lower than that by rail; this depends, in most cases, on the absence of tolls on waterways. It must be noted that the cost of water carriage varies greatly, according to the geographical and technical conditions of the different waterways. Moreover, we must not compare the cost of carriage by water and by rail merely on the basis of the rate per ton-kilometre; this does not suffice, for when there is competition between a waterway and a railway the waterway always takes longer; in fact in the latter case gradients must be gentle and opposing gradients have to be avoided, consequently a more or less sinuous route has to be adopted.

It follows that the distance the goods have to travel may be lengthened considerably; on the Seine the waterway is 80 per cent longer than the railway; on the Rhine, it is only 17 per cent longer.

The freight increases rapidly with *the gradient of the waterway*, as any increase in this involves on rivers a large increase in the cost of haulage, and on canals a multiplication in the number of locks, causing much loss of time; the passage of each lock takes, in fact, from twenty minutes to half an hour.

Then also *the size of the boats* has to be taken into consideration. The difference is considerable; thus we have the 60-ton barge on the Berry canal, and then the Flemish 300-ton lighter used in Belgium, in Holland and in the north of France; next we find in Germany 400-ton barges on the Brandenburg canals, and 600-ton barges on other canals. Thus there are the river boats attaining, in Germany, to 600 tons on the Elbe; in France, 1,000 tons on the Seine; 2,000 and 2,500 tons on the Rhine; and finally in Russia, up to 9,000 tons on the Volga.

Finally, we must mention, as a factor exercising considerable influence on the freight, *the method of traction;* this varies from human to animal traction, and to mechanical traction operated by steam and by electricity.

If we take all these factors into consideration, we must conclude that a bad river is worth less than a good canal, where there are not too many locks; and that a good canal is worth infinitely less,

from the point of view of cost, than a good river.

This difference has to be remembered, for as regards rates, the railway easily competes with a bad river, fairly easily with a canal, even a good one, but only with very great difficulty with a free-running river, such as the Rhine and the Volga.

Besides the cost of carriage proper, we must also compare the terminal charges; these are, generally, rather higher with waterways than with railways. This advantage becomes considerable when the manufacturer who utilizes the railway is connected with it by a private siding; the development of private sidings is a very powerful weapon for the railway. We will quote some figures which show the advantage of these sidings to the French Northern and to the French Eastern Railway.

The third factor to consider is *the length of the journey* to be effected.

As regards short distances, we may say that the obtaining of the traffic does not depend on the cost of carriage proper, but on the terminal charges. The traffic will go wholly by that of the two ways, which has the lowest terminal charges or the greatest facility of access.

At medium distances, the competition of waterways makes itself felt; at large distances, it is generally said that the ordinary waterway has a great advantage. That is often true; that is so in Russia where the mean length of journey of rail-borne goods is half that of water-borne goods, and also in Germany, where it is 114 kilometres as against 290 kilometres (71 miles as against 180 miles). In France, on the contrary, the mean length of journey is the same in both cases, namely about 150 kilometres (93 miles).

It must be noted that this advantage of the waterway at long distances is not general, and that it is largely influenced by the rating system adopted by the competing railway. In this respect, there is a very marked difference between France and Germany : in Germany, rates are, generally, made on a fixed basis; in France, on the contrary, on a differential basis, decreasing with the distance; it follows that in France the length of journey at which the waterway competition is most effective is frequently a medium one, while if great, the kilometric basis of the railway tariff becomes less than the kilometric basis of the waterway tariff, so that for distances of more than 600 to 800 kilometres (370 to 500 miles) the advantage is again with the railway.

The next chapter of our report deals with the time required for the journey.

In this case the railway has a marked advantage if we consider the ordinary time the railway takes, and not the legal time specified in the rules which the railway is bound to observe.

In our report we mention instances in which the waterways can carry certain goods almost as quickly as the railway. It is in Germany that these instances are found, owing to the very favourable topographical conditions of these waterways and to the excellent organization of the shipping service from the commercial point of view, as well as from that of fast steam haulage.

A remarkable instance of these quick-freight services is to be found on the Elbe, where there are very well-organized shipping companies running boats at short intervals. In particular they take goods

from the frontier of Bohemia to Hamburg, a distance of about 600 kilometres (373 miles). In France, the average speed of carriage on waterways does not exceed 15 to 20 kilometres (9·3 to 12·5 miles) per day. On the Rhine, the average speed may be estimated at 70 kilometres (43·5 miles) per day, and on the Volga, at 75 kilometres (46·6 miles) per day.

Now what is the influence of *the nature of the goods?* Are there goods specially suitable either for carriage by water or for carriage by rail?

One can mention coal as preferring, at equal rates, the railway, owing to the deterioration it undergoes if carried by water, owing to the damp and to the long time required for the journey; this leads to heating of the coal and to its decomposition.

Messrs. Gruner and Weyhemmayer have given particulars about the deterioration of coal carried by water. This deterioration is a fact, and one which is of great importance to manufacturers; it is of less importance to retail coal dealers, whose customers have no apparatus for determining the number of heat units produced by the combustion of a given weight of coal.

In the case of coke, the deterioration is even more marked than in the case of coal; it is estimated at from 1·50 to 2·50 francs per ton (1*s.* 2·63*d.* to 2*s.* 0·39*d.* per English ton), according to conditions.

The sixth chapter of the second section of the report considers the influence the value of the goods may exercise on any preference to be given to the one or the other means of carriage.

In this connection there is a prejudice which has to be overcome: for forty years it has been repeated that railways are suitable for carrying goods of greater value, while waterways are suitable for carrying goods of less value. That is an error, for boats can take goods of greater value, and railways can take goods of less value. We give instances of this in our report.

As regards goods of a certain value, the disadvantages peculiar to waterways, less security and slower conveyance, are counterbalanced by the fact that on railways goods of greater value are charged higher rates than goods of less value.

In order to make competition possible, however, it is necessary that the speed of the water carriage should be sufficiently great and that the service should be properly organized. This is the case on the Elbe and on the Rhine.

On the other hand, railways do not refrain from carrying goods of little value and there are even railway systems on which heavy goods form the bulk of the traffic. In France, taking all the railways, the heavy goods amount to 70 per cent: on the waterways 25 per cent of the goods are of greater value. As regards coal, if we compare railways with waterways, we find that it forms 28 per cent of the total railway traffic and 32 per cent of the total waterway traffic.

We next examine the habits of the clientele. A fact which has to be remembered is that the waterways, as they carry large consignments at a time, can only appeal to very large business firms or manufacturers, while railways include medium-sized and small firms among their customers.

Waterways can only be used by manufacturers who make large stocks, who ac-

cordingly have large works and a more or less large working capital.

In the eighth chapter of the second section of our report, we note that among all the centres to or from which goods are consigned, it is above all the great centres which most attract waterway traffic. The great centres from which goods are sent by water are in mining or in industrial districts, and the places to which they are sent are generally the large cities, owing to the preponderance of water carriage in the case of building materials and of cereals.

In the ninth chapter of our report, we more especially consider a question of some importance to France and to Germany.

Waterways as compared with railways are far more important from the point of view of imports than from that of exports.

This is due to two causes : firstly, to the favourable conditions under which goods can be transhipped from the cargo-boat to the barges; the goods are generally cereals arriving from America in bulk, and which can be transhipped at once. On the other hand, if it is a question of sending cereals from a country producing them to other countries, the consignments arrive in small lots; consequently, they cannot be transhipped at once, and they must be stored before they are put on board the cargo-boat.

The second reason, and the more important one, is that the railway is hampered by protectionist opinions, in most countries, when it is a question of making tariffs to favour imports.

This fact has been observed very clearly on the Seine; in our report we give curves showing the decreasing or stationary importance of certain railway traffics, and the continual increase of the same traffics on waterways.

This is also marked in the case of Germany, where the cereals traffic on water exceeds 3 million tons, as against only 100,000 tons on the railways.

In the tenth chapter, we examine how the equilibrium between the two systems of carriage, established as just described, becomes disturbed. This equilibrium is not stable; it is influenced by the variations in freight, which goes up when traffic increases and goes down when it decreases, while railway rates remain the same.

Freight is affected by three chief factors, one of which is of a technical character; this is the state of the waterway, as affected by the depth of the water, the current, etc. During each year, the freight varies with the season, with the amount of traffic. Thus in France the freight for carrying coal from the North to Paris goes up in autumn and goes down in spring.

The variations in the economic activity also influence the freight; this is a fact which we have tried to make clear in the table given on page 90 of the report (1).

During boom times the increase of the traffic on railways is always greater than on waterways.

The waterway does not appreciably increase its traffic-capacity during those times, while the railway, which is compelled to carry, increases its traffic-capacity, and hence takes a greater proportion of the traffic.

It would seem that the inverse pheno-

(1) See also *Bulletin of the Railway Congress*, number of March, 1910, p. 1186.

menon should be produced during times of slump, but we have not found any evidence to establish this; it is found, in most cases, that the losses on waterways are neither larger nor smaller than those on railways. This may be explained by the fact that the carriage of articles of food, which forms an important fraction of the railway traffic, is not influenced by economic crises, and, moreover, the railways cater for nearly all the smaller firms. Now the effects of economic crises only make themselves felt at a subsequent period in the case of smaller firms, while it affects big firms almost at once.

We now come to the eleventh chapter of the report, dealing with the measures taken by the railways to fight the competition of waterways.

This competition can be direct when the railway carries the goods from end to end. It is often hampered by administrative regulations which, except in Hungary, in Austria and in Russia, trammel the freedom of the railways as regards the modification of the rates. These regulations are rather severe in France; we give, on pages 96 and 97 of our report (1), instances which show that in some cases at least the railway is completely beaten by the waterway.

The competition can also be indirect, that is to say, it can be against mixed traffic, that is to say, in case the waterway is used for part of the journey and the railway for the other part. The railway can then proceed in two different ways, either reduce the size of the zone for which mixed carriage is cheaper than direct railway carriage (this is done in Germany along the Rhine and the Elbe), or when mixed carriage cannot be avoided, arrange matters so that the route taken is such that the rail journey is a maximum.

We give an instance of such indirect competition, in particular in Russia, where tariffs are arranged to retain the traffic between the Volga and Moscow and St. Petersburg on the railway for as long a distance as possible. In Germany, this competition takes the form of exceedingly low rates for the coal and minerals carried on the Rhine, the Elbe and the Oder.

We now come to the third section of our work, in which we have tried to determine what the net cost of carriage by rail may be, in the case of goods of the kind carried on waterways.

The net cost of carriage on waterways is very easy to ascertain, as owing to the competition existing between small boats, it may be assumed, without fear of error, that the net cost of water carriage approximates to the mean freight, which covers the cost of traction, the amortization of the boat, and the ordinary pay of the boatman, considered as a workman.

On railways, that is not the case; we consider in the first place the case where there is competition between a waterway and an existing railway, and we estimate the extra cost incurred in order to run an additional train.

Assisted by investigations made and brought to our notice by several French railways, especially the French Eastern, we found this to be 0·65 centime per ton-kilometre (0·102*d.* per English ton-mile).

(1) See also *Bulletin of the Railway Congress*, number of March, 1910, pp. 1192 and 1193.

This figure only includes the expenses special to the train, the cost of coal and oil, the interest and amortization of the locomotives, the pay of the drivers, firemen and other train men; these are specialized expenses and it would be a mistake to think that the figure so obtained by us represents the net cost. It is much too small.

In order to allow for miscellaneous expenses, we have taken the average for the French railways, and this is certainly too much.

As for the expenses of the traffic service, these are very small if we deduct the expenditure on train men, included among the specialized expenses; in order to allow for them, we have added 0·20 centime per ton-kilometre (0·031*d.* per English ton-mile).

Finally we have to consider the cost of the additional works made necessary by the growth of the traffic. We have made the calculations for this growth for the last twenty years on the French Northern and the French Eastern, and this calculation has given the figure of 0·34 centime (0·053*d.* per English ton-mile) which has been added to the previous amount.

Thus we obtain a total of 1·19 to 1·20 centimes, which may be considered the net cost of carriage of a ton of coal or of mineral per kilometre (0·187*d.* to 0·188*d.* per English ton-mile).

In the second example, we have taken the case where it is necessary to build a railway. The French Northern Railway has supplied us with particulars of a calculation showing the net cost, and this does not exceed 1·20 centimes per ton-kilometre (0·188*d.* per English ton-mile).

Our conclusion is as follows : we arrive at the same result as before, that is to say, that the net cost of carriage of goods similar to those carried on waterways, can be estimated at between 1 and 1·20 centimes per ton-kilometre (between 0·157*d.* and 0·188*d.* per English ton-mile) on railways.

This cost is less than the freight on average and mediocre waterways, especially if we allow for tolls; but it is appreciably greater than the freight on large rivers, such as the Rhine and the Volga.

It can hence be concluded that railways can nearly everywhere compete advantageously with waterways if these had to pay for their maintenance.

The only exception is in the case of large rivers with small fall, on which it is possible to carry goods in large lots. (*Applause.*)

Mr. Jebb, *reporter for Great Britain.* — Mr. President and Gentlemen, I must apologise for speaking in English but you will all, I am sure, be relieved to hear that I intend to occupy only a very few minutes giving you an abstract of the short paper I have written on the subject which has been referred to me, *viz.* :

" The investigation of the influence of waterways considered as feeders and as competitors on Railways " in Great Britain, her colonies and India.

After giving the subject my best consideration and carefully analysing the replies which were sent by the railway companies to questions I submitted to them I have come to the following conclusions :

I. *Great Britain and Ireland.* — That the influence of waterways, considered as *feedeers*, on railways is negligible, except

in the case of the Birmingham Canal Navigations. This canal system is in many respects unique; it forms a network of canals in the mining district of South Staffordshire, is 159 miles in length and there are some 500 private branches or basins connected with it.

Works of almost all descriptions have, from time to time, been built on the banks of the canal and many of these works have no direct communication with the railways.

Three of the great Railway Companies — the London & North Western, the Great Western and the Midland — whose lines intersect the district, have therefore constructed transhipping basins and depots at many convenient points and made branch railways to them; traffic is brought by boat from works to these basins and put on the railway The Birmingham canal may therefore be considered as a useful feeder to the railways.

The total amount of traffic (it is chiefiy from canal to railway) interchanged at these depots is about 1,200,000 tons per annum (the annual traffic on the canal being about 8 million tons). Of the forty-one railway companies in the United Kingdom of Great Britain and Ireland, about one sixth of them have waterways to compete with — details of these are given in my report.

The competition of the waterways is in some districts considerable, but it does not appear, at the present time to be either increasing or diminishing to any material extent.

It is probably less than it was thirty or forty years ago : there is, however, one exception *viz.* : that of the Manchester ship canal.

This canal is 35 $^1/_2$ miles in length and was opened for traffic in 1894 — it begins at Eastham near Liverpool and ends at Manchester. Large docks and quays have been constructed at Manchester for the accommodation of the largest cargo-carrying vessels and extensive warehouses have been built.

The effect of this canal, as a competitor with railways, is that oversea traffic which, if the canal had not been made, would have been landed at Liverpool, Birkenhead or other ports, thereby giving the railway companies the carriage to Manchester and other towns, is now delivered at Manchester by ocean going vessels. The amount of traffic so diverted is considerable.

Sea competition is very effective and most of the great railways are affected by it — traffic is conveyed between nearly all ports by coasting services.

The Royal Commission on Canals and Waterways to which I have referred in my paper has now reported. There were nineteen members of the Commission — sixteen have signed the majority report, but of these, four dissent in strong terms from their recommendations, a fifth makes independent reservations, while three have not signed at all but made separate reports in which they severely criticise and condemn the majority report.

The majority report recommends the formation of " a Waterway Board " to " review the whole situation on the lines of practical business " and " if satisfied " that the improvement of the canals between Birmingham and the ports of Liverpool, Hull, London and Bristol would be desirable, to propose a scheme for submission to Parliament.

The majority report is in favour of pub-

lic money — about £17,500,000 — being provided for the improvement of these canals.

Many of those who have most carefully considered the question are of opinion that a very much larger sum would be required to make these new canals and that if they were made, they would not pay the cost of maintenance. The witnesses who gave evidence in favour of improving the canals made it quite clear that the public could not be depended upon to find any money, and it was evident that the chief object of the witnesses was to bring down railway rates.

II. *India and Colonies.* — The waterways as they now exist interfere only to a slight extent with the earnings of the railways. Some interesting particulars have been supplied by the railway companies which have been embodied in my report.

The President. (In French.) — The reporter for America being absent, I will request Mr. Colson kindly to give us a summary of Mr. William Hoyt's report.

Mr. Colson. (In French.) — Mr. Hoyt's report deals with the question of waterways in America.

Towards the middle of last century many canals were built, most of them by companies. When the railways began to develop, the companies gave up nearly all those canals, as they were no longer of any real use for points where railway communications exist. Thus 2,444 miles of canals, which had originally cost over £16,000,000, were simply and purely abandoned. One of the canals belonging to the State of New York had been of considerable importance, namely the Erie canal.

The United States are richly endowed with natural waterways. But the traffic on these ways has become very small, even on the Mississippi; at St. Louis shipments which amounted in 1890 to 600,000 tons, now only amount to 89,000 tons. The only important traffic which still exists is on the Ohio, chiefly coal from Pittsburgh.

The United States have, on the other hand, an incomparable system of inland navigation, namely the great lakes, where the conditions are such as to defy any railway competition. But this is a very special case, approximating much more to ocean navigation. The traffic has developed to an extraordinary extent.

In the United States, as in Europe, generally, the government is trying to stimulate inland navigation; the State of New York is enlarging the Erie canal: it does not hesitate to incur an expenditure of over £20,000,000 in order to make this canal accessible to boats drawing 3·50 metres (11 ft. 6 in.) of water. The federal government has been investigating a very vast scheme for improving the waterways, a scheme which has not yet been sanctioned by the legislature.

Mr. Merczyng, Russian State Railway. (In French.) — Gentlemen, you will allow me to add a few words.

It is a question of a technical development which in the near future will exercise great influence; I mean mechanical traction and more especially electric traction on waterways.

At present, except in the North of France and in Germany, no large enterprises of this kind are yet to be found; but in Russia schemes are being prepared for

our large canal systems, especially those around lake Ladoga.

It is proposed to develop mechanical traction by utilizing the water-powers.

Thanks to the progress of electro-technics, we shall see the waterways operated like railways, and as on railways, services of trains of boats running at fixed hours will be organized on those waterways.

There is already a fixed time-table on the Brussels-Mons canal in Belgium, and we shall soon see the traction monopolized by great companies or by the State, and rates made according to the value of the goods carried and the liability incurred, just as in the case of railways.

From this time onwards, the equilibrium between the railways and the waterways will be completely modified.

Such is the future.

At a future session of the Congress, I think that we shall bring forward information which will entirely change the aspect of the question.

Mr. Timonoff, ministry of ways of communication, Russia. (In French.) — I will begin by paying my respects to our reporters; the reports which you have had an opportunity to read, on the question of the influence of waterways on railway traffic, are really very able.

If you consider the difficulties of combining all the constituent parts of those reports, you will recognize the great work done.

Messrs. Colson and Marlio's report, which contains so many statistics and to which so many tables are annexed, has certainly involved weeks and even months of correspondence and of work in order to be completed, so as to be submitted to the Congress.

Anybody who would try to criticize these labours would certainly have a thankless task.

That being said, I ask permission to add some new information to that supplied to you, concerning the waterways in Russia, and to give you some particulars which you will perhaps find of interest.

It has to be noted that matters have gone on in the same way in Russia as in England and the United States of North America, as already mentioned.

In accordance with the wishes expressed by the Russian parliament, the State Duma, the ministry of the ways of communication appointed a commission for investigating the question of waterways. This commission is intended to examine all the points bearing on the question of the importance of waterways compared with that of railways.

This commission, which by now has been at work for several months, has found that the time had not yet arrived for generalizing the question of competition of railways and waterways.

It is impossible to lay down as a general principle whether railways should be built or waterways constructed; in every country and in every district, this is a question of kind.

The general opinion expressed in the reports which are before you, is in favour of railways: but reservations have just been made in the case of the great lakes in North America, and also in the case of the Manchester ship canal. That could also be done in other cases.

The Volga has been mentioned, and it

has been stated that that was a river along which there was no railway.

Those are questions of kind, and it is advisable to continue their investigation, for the time has not yet come for drawing possible conclusions about the influence of the competition between railways and waterways.

I observe that at the Railway Congress there is naturally a certain bias in favour of railways; but I have also been present when the Inland Navigation Congress discussed the same question, and there the bias was in the opposite direction.

In 1910, we are in a better position to discuss the question. Yesterday, at the opening meeting, we were reminded of the history of the work of the Congress during twenty-five years, and of the wonderful way in which this organization labours and investigates, but it has not been mentioned that the Railway Congress has given rise to analogous institutions in other branches of industry. Thus there is at present a Permanent Commission of the Inland Navigation Congress, a commission which meets at the same city as the Commission of the Railway Congress, and thus there is perhaps a possibility of thorough investigation, which could be undertaken by the bodies working jointly, and which would probably be richer in results than any which each of these congresses could obtain separately.

These are the considerations which lead me to think that we should not adopt too definite conclusions at the present session, for this is a question of kind, not only in the different countries, but also in the different districts of one and the same country.

There is a whole series of important investigations which have to be made.

These investigations could be made under more satisfactory conditions if a proper programme were to be drawn up jointly by the Commission of the Railway Congress and by the Commission of the Inland Navigation Congress, a programme which would include all the points necessary, and would be sent to all the members of both permanent commissions.

Under those conditions, we could then at the next Congress have a report which would perhaps lead us to more definite conclusions.

Therefore I have the honour of submitting to you the following resolution :

" It is desirable that in all countries where inland navigation plays or can play an important part, the study of the reciprocal influence of waterway and railway carriage should be carried out in a continuous and systematic manner, in accordance with a programme drawn up by the Permanent Commission of the Railway Congress, acting conjointly with the Permanent Commission of the Navigation Congress."

Mr. Riché, French Eastern Railway. (In French.) — I should like to make two short observations to you in connection with the proposition which has just been made of making a sort of agreement between the Railway Congress and the Navigation Congress.

The first is purely a matter of form. It seems difficult, considering the Constitution of the Railway Congress, which defines its object and scope, that we should vote for the principle of making an agreement with another association which has

its own individuality and which must follow its own road.

The programme which could be drawn up, conjointly, would only be theoretical, for there will always be a profound difference between the organization of railways and the organization of canals. That difference has been set forth very clearly in Mr. Colson's report : in the one case the cost of construction of the canals, of their maintenance, of their amortization, is not allowed for, while in the case of railways this cost is included in the working expenses, and the capital becomes amortized.

If a joint programme were to be drawn up, ways and means of carrying out this programme would still remain to be found.

Would the companies be authorized to make competitive tariffs? I do not think so, at least not as far as France is concerned.

On the other hand, it would be necessary to have homogeneous shipping rates and a combination of companies organizing a joint system.

At present shipping is very scattered; there are very many small ship-owners, who make a poor living, but who have not even enough capital for their own purposes, so that they are obliged to borrow money at high rates in order to make it possible for them to carry on their business, to pay and feed their men.

It seems very difficult to organize the shipping services so as to form a general combination, which until now has never existed. It has never existed because there are shipowners, but no shipping services, above all in France, where neither a joint organization nor common rules are in existence.

There are in fact great difficulties in organizing and operating shipping.

Mention has been made of modifying the conditions of carriage, of improving them, by applying electric or mechanical traction. It is evident that under those conditions, it would become easier to compare the two methods of conveyance, waterways and railways, but at present we, the Railway Congress, must limit ourselves to recording that in the present state of affairs there are such profound differences between waterways and railways, that no comparison can be made, and that we must allow for differences of kind, not only from country to country but also from district to district.

Mr. Franke, Prussian State Railway. (In German.) — I equally hesitate to accept the proposal brought forward by Mr. Timonoff, and my objections are of the same order as those brought forward by Mr. Riché in the second part of his speech. I am also of opinion that the Congress must be content with recording that owing to the difficulties and differences which exist in different contries, it is difficult to make a uniform comparison. The report drawn up by the reporter shows in fact that conditions vary so much from country to country that it is impossible to find terms of comparison for any uniform statistics, and very difficult to come to an agreement about this with the Inland Navigation Congress.

This is how we proceed in Germany : we deliberately avoid all competition with waterways. The State which constructs and operates the railways also constructs

the canals and improves the rivers. It knows that these waterways cannot yield the same return as the railways. Nevertheless it constructs them because it knows that countries, and especially our German countries, have an urgent need of both of these systems of conveyance, waterways and railways. Statistics of this kind would hence not be of much use. Accordingly my chief objection to the proposed resolution is that conditions vary so much from country to country that it is difficult to find any good basis for the comparison.

Mr. Colson, *reporter*. (In French.) — We have drawn up conclusions summarizing the statements contained in the reports. In accordance with the custom of the Railway Congress, these conclusions are not directed towards proposing any measures which should be applied, but limit themselves to recording the results of the reports and of the discussion.

Before reading out these conclusions to you, I should like to say that I will very willingly support Mr. Timonoff's resolution. I will add, in this connection, that I think that Mr. Riché believes this resolution to be much more comprehensive than it really is. Mr. Timonoff does not ask for an agreement between the Railway Congress and the Inland Navigation Congress as to the relations between the two systems of conveyance, an agreement very difficult to realize. What he asks for, is an agreement as to the method of investigating the comparative advantages of the two systems of conveyance. The measures to be taken in order to make this investigation effective, while taking both sides of the question, will be arranged by joint agreement of our Congress and the Navigation Congress. That is a desire which I share. I have been present at navigation congresses and I have tried to have this point discussed. I think that the railways have very much to gain if during a joint discussion, the partisans of navigation are placed in a position to explain how and why they think their waterways superior to railways. I think that railways would certainly benefit enormously by this, in public opinion.

Hence I support Mr. Timonoff's resolution. That being said, these are the conclusions submitted to the meeting for approval. They are somewhat long, but if we only state that we consider our system better than the competing system, without explaining why, we do not say much.

" The Congress notes that waterways as a rule play a much more important part as competitors than as feeders of railways. The factors which influence the division of the traffic between the two ways are as follows :

" 1° *Rates*, which are generally lower by water than by rail; this is more especially due to the fact that railway rates are fixed so as to remunerate the capital spent on construction as much as possible; on the other hand, as regards waterways, States sometimes supply capital and attend to the maintenance without remuneration, or else are satisfied with collecting tolls which only exceptionally cover the cost of maintenance; only in England is the contrary the case, and there inland water carriage over long distances has become very rare. In spite of the advantage granted everywhere else to their competitors, railways, when free to modify their rates for

the traffic which is competed for, without granting other classes of traffic reductions in rates incompatible with the charges incurred, can easily lower their rates without losing all their profit, and make cheaper rates than those obtainable on smaller waterways, with many locks and numerous curves. Only with difficulty do they reduce their rates to the level of the freights charged on large rivers with a gentle gradient, well regulated and provided with the necessary equipment, as in the case of the Rhine and the Volga; and their rates always remain higher than the freight on the great lakes which are similar to inland seas;

" 2° *Terminal charges*, which have a notable influence on the choice between the two ways, when only one of them is in direct connection with the establishments of the consignors or the consignees, either because these are located on the banks of the waterways, or because a private siding connects them with the railway. This factor is decisive in the case of short distances; competition begins at medium distances, and the railway gains or loses influence, as the distances increases, according to whether the tariff is a differential one, or whether on the contrary it remains practically proportional to the distance;

" 3° *The time required for the journey*, which is much less on the railway, except in the case of relations where the economical and geographical situation of the waterway makes it possible to use powerful steam-engines; on the other hand, water-carriage is nearly everywhere subject to interruptions which do not affect railways;

" 4° *The nature of the goods*, which resist more or less well the effects of water-carriage. It is by no means correct (as is often said) that the line of separation is formed by the value; water-carriage is used for goods of a rather considerable value per ton, when technical and commercial conditions make a regular service possible; its disadvantages are then counterbalanced by the relatively high rate which railways charge for such goods; railways, on the other hand, can carry large consignments of heavy goods at as cheap a rate as the waterway, on lines of easy profile serving the same relations. The objections to the longer time required for the journey, and to the effects of damp, may be as important for low-price goods (coal) as for more valuable articles;

" 5° *Direction of traffic at seaports.* — Waterways take away from railways a larger fraction of the import traffic than of the export traffic, especially while regulations and public opinion prevent railways from applying the same reduced rates to imports as to exports and also because direct transhipment from ship to lighter is easier for oversea goods carried in large quantities by sea than for home produce which generally arrives in small quantities from various parts of the country, to be shipped when a ship is available;

" 6° *Variations in the activity of the traffic*, due to the season or to economical crises. The railway has much more flexibility in meeting sudden changes. Variations in the activity of business produce, in the case of railways, large variations in the amount of traffic offered; these only in very exceptional cases cause alterations in the rates. On the other hand, the waterways retain a less variable tonnage of the traffic competed for, by raising or

lowering their rates according to the state of the market.

" Next considering the position of waterways as feeders of railways, one sees that if the latter were able to modify their rates at their own convenience, they would nearly always be able to carry consignments the whole way, giving the public as favourable conditions as mixed carriage would, while at the same time realizing a higher profit to remunerate their capital.

" A railway administration has not much interest in cooperating with inland waterway services (unless these are of a quasi-marine character) except in three cases :

" *a*) When railways are prohibited from making lower rates so as to retain the traffic for the whole distance, as is generally the case with imports;

" *b*) When their lines are able either to receive from waterways or to bring to them traffic which might be carried the whole distance by a rival railway;

" *c*) When in a country where the railway system does not yet provide for all important currents of traffic, as in Russia, the State was wise enough to connect first by means of railways the centres not already connected by waterways, so that a mixed route is the only one possible for many articles.

" If it is necessary to establish a new line to provide for a considerable flow of traffic, for which existing lines do not suffice, and if the topographical and economic conditions would make an artificial waterway possible, the same result can be obtained with less expenditure, by constructing a railway."

Additional clause proposed by Mr. Timonoff and accepted by the reporters :

" It is desirable that in all countries where inland navigation plays or can play an important part, the study of the reciprocal influence of waterway and railway carriage should be carried out in a continuous and systematic manner, in accordance with a programme drawn up by the Permanent Commission of the Railway Congress, acting conjointly with the Permanent Commission of the Navigation Congress."

I think it is advisable not to decide today about these conclusions, but to wait until they have been printed in the *Journal quotidien de la session* so that each of us can examine them at leisure. We could again consider the subject at our meeting tomorrow afternoon. (*Signs of approval.*)

The President. (In French.) — This proposal seems to meet with approval. That shall accordingly be done.

Meeting held 6 July, 1910 (afternoon).

The President. (In French.) — Before discussing the proposed conclusions, I call upon Mr. Hale to address the meeting.

Mr. Hale, American Railway Association. — I hope Mr. Colson 's conclusions will be passed by the Congress. I draw special attention to the sixth paragraph on

the variation in the amount of traffic offered, and the importance of an understanding by the public of this phase of the question. It is true that railroad service is more elastic than service by waterway, but too often a stoppage of water service throws business suddenly to the railways which they cannot justly be expected to carry, and curiously enough *their efforts to serve the public on such occasions are seldom appreciated.*

I believe that the most important conclusion stated was that under ordinary circumstances a railroad is cheaper to build and maintain than a canal especially as the statement was thoroughly proved by Mr. Colson.

Mr. Hoyt, *reporter.* — The United States National Waterways Commission in its report recently issued says :

> The average European freight rates on railways paralleling water routes are higher than those on lines similarly situated in the United States, and European rates for water-borne carriage, in some instances, even where the traffic is very large, are as high or higher than on railways in the United States where traffic is likewise large.

Evidence of the truth of this is found in a comparison of our United States railway rates with those of Europe.

In Germany, the average railway rate per ton-mile is 13 mills, in France, it is 14 mills, in Belgium, it is between 16 and 17 mills.

In the United States, our average rail rate is only 7·54 mills per ton-mile, or 58 per cent of what it is in Germany, 54 per cent of what it is in France and 47 per cent of what it is in Belgium.

And if we look a little further, we shall see that our railway rates in the United States compare very favourably with European water rates.

On the River Rhone in France, the highest rate is 15·6 mills per ton-mile, and the *lowest* is 7·8 mills, which is higher even than our United States average rail rate.

Then on the Seine, we find the figures running from 26 mills to 56 mills, — the last, seven times greater than our United States average railroad rates.

But, taking an average of all the waterways of France, the rate is not less than 6 mills, and in Belgium, it is approximately 6·5 mills; these figures being based on the actual length of haul.

It was pointed out, however, by Messrs. Colson and Marlio in their report, that waterways are of necessity considerably longer than competing railways in the same territory, and if we take this fact into account, and compute the rates on a basis of distances by rail, we shall find the average water rate in Germany to be approximately 6·5 mills, and those in France and Belgium are 8 mills; the last being somewhat higher even than the United States average rail rate.

This figure of 7·54 mills, it must be remembered, is by no means as low as that on some of our representative American roads handling a large traffic.

In 1907, the average rate per ton-mile on the New York Central was 6·4 mills; on the Pennsylvania, it was 6·3 mills; on the Illinois Central, 5·8 mills; on the Lake Shore and Michigan Southern, 5·27 mills; on the Big Four, 5 mills; on the Norfolk & Wertern, 4·95 mills, and on the Chesapeake & Ohio, 4·33 mills.

*

It would seem therefore that conditions in the United States are radically different from those in Europe as regards competitive rates on railroads and waterways, and that specific conclusions based on experience here will not apply to the United States.

Mr. Haines, United States Government. — The first paragraph of this report maintains the general proposition that navigable routes play a much more important part as competitors to railways than as feeders. This general proposition is however restricted by the exception thereto attached, that " in America, experience proves that competition by canals may not be serious".

It would seem to be useful, in this connection, to recall something of the history of transportation in the United States. At one time, the system of canals in that country promised to be one of the most important in the world. General Washington was perhaps the first to appreciate the value of artificial waterways in opening up to settlement the country which extended westward of the Alleghany mountains. He interested himself personally in the improvement of the navigation of the Upper Potomac river, as part of a system of water and land transportation connecting the waters of the Chesapeake bay with those of the Ohio river; and this undertaking was the forerunner of the Chesapeake & Ohio Canal. He also pointed out the part which the navigation of the chain of great lakes, Ontario, Erie, Huron, Michigan and Superior, was destined to play in the spread of civilization westward. He indicated the site of the present city of Detroit as the point at which the traffic upon these lakes must converge, and referred particularly to the advantages for the location of a canal which were offered through the country south of lake Ontaria, from lake Erie at Buffalo, and along the Mohawk river to the navigable waters of the Hudson river near Albany. He even glanced at the possibility of an artificial waterway to connect Upper Lake Huron with the Ottawa river and Montreal.

The project of a canal between Buffalo and Albany, outlined by the prophetic genius of Washington, was realized in the construction of the Erie Canal, commenced in 1817 and completed in 1825. The completion of this work aroused a general interest in canal construction. The region of Lower Canada was brought into closer commercial relation with the United States by a canal which connected the waters of lakes George and Champlain with the Hudson river. The facilities afforded by the Erie Canal for reaching the vast territory tributary to the great lakes, laid the foundation for the subsequent commercial preeminence of the city of New York, and aroused a spirit of emulation among the merchants of Baltimore and of Philadelphia, who had hitherto enjoyed a virtual monopoly of the trade between the Atlantic coast and the region between the Ohio river and the great lakes. The Chesapeake & Ohio Canal was projected as a substitute for the improvement of the Upper Potomac river, in the interest of the city of Baltimore, and the State of Pennsylvania was induced by the citizens of Philadelphia to undertake the construction of a system of transportation, partly by canals and partly by the improvement of available watercourses, connected by

inclined planes over the intervening mountains, which brought the waters of Delaware bay into direct connection with the Ohio river. The topography of the region between the great lakes and the Ohio and the Mississippi rivers, facilitated the construction of artificial waterways which connected these two great systems of navigation; and by 1835 there was a canal mileage of 2,617 miles in operation in the United States, of which the greater part was devoted to the traffic of the trans-Alleghany region.

In the competition for this traffic, the commercial prosperity of Baltimore was threatened, by reason of its unfavourable position as to communication by artificial waterways with the Ohio river. In this dilemma, attention was drawn to the new method of the iron way which was then being developed in England. In 1827, the merchants of Baltimore projected a railway to Wheeling on the Ohio river, a distance of 378 miles, at a time when there was no other railway in existence over fifty miles in length; and two years before Stephenson had built the locomotive *Rocket* for the Liverpool & Manchester Railway Company.

What has been the result of the ensuing competition between the canal and railroad systems extending across the mountain ranges which form a barrier between the Atlantic coast and the territory extending illimitably westward; a region already favoured by Nature with such navigable routes as the great lakes and the St. Lawrence river on its northern boundary and the internal Mississippi river system to the gulf of Mexico? Railways were no longer projected with the idea of facilitating communication between water routes, but to compete with them. They paralleled the canals and the rivers so effectually that commerce forsook them. It is estimated that a canal mileage of four thousand miles, costing $150,000,000, has been rendered useless by railway competition. The steamboat service on the Ohio and the Mississippi rivers, that had built up the cities of Cincinnati, St. Louis and New Orleans, could not successfully maintain a rivalry with the new mode of transportation; and these cities were compelled to invite railway communication in order to retain their commercial relations, The artificial waterways have been substantially abandoned in the coal regions of the Atlantic seaboard and in the territory between the great lakes and the Ohio and the Mississippi rivers. Even the tide of commerce which had so long pulsated in full current through the Erie canal has diminished to a sluggish stream. Little is left of the once vast commerce on the Mississippi river, save the long-distance traffic in bituminous coal for which the railroad managements do not compete.

The remaining domestic traffic that is waterborne is now held in bondage to the railways. The grain trade continues on the great lakes, in connection with the rail routes from the lake ports to the sea coast, until the close of navigation in winter permits the application af all-rail rates. A vast commerce is still conducted on these inland seas in iron ore, which is transformed at the lake ports into products that cau be more profitably transported by rail. The steamships engaged in the coastwise traffic are in alliance with the rail lines extending into the interior; and even the traffic over the isthmus of Panama is controlled in the interests

of trans-continental railway corporations.

Such has been the outcome of about eighty years of competition between waterways and railways in the United States. But popular opinion is being aroused in behalf of improved waterways and it has procured the political and financial support of the governments of several of the States in the Union and of the federal government as well. The State of New York is endeavouring to restore the usefulness of the Erie Canal by enlarging its dimensions at an estimated cost of over $100,000,000; the federal government has made still larger appropriations for deepening and maintaining the navigable channels of the Mississippi river system; a movement is on foot to connect and utilize the succession of bays, gulfs and sounds that borders the Atlantic sea coast; the Canadians are facilitating the navigation of the great lakes and of the St. Lawrence river so effectually as to deprive the city of New York of its preeminence in the export grain trade; and the far-reaching effect of the proximate completion of the Panama canal is as yet not fully comprehended.

But all these efforts at improvement of the natural and the artificial waterways of the United States will not make them efficient competitors of its railroad system. That system has superseded them because it provides a speedier, cheaper and more convenient mode of transportation; one with less interruption between the ultimate producer and the ultimate consumer. At present, it requires eight days to accomplish a voyage by water between Buffalo and New York. A merchant in the latter city may order from Buffalo by telegraph a trainload of fifty cars, each of thirty tons of grain, and receive it within thirty hours on floats alongside a trans-Atlantic steamship, and at a freight charge which has been for years so low that the Erie canal has ceased to be a competitor for this traffic.

Where competition by rail routes is available, artificial waterways are no longer desired. Their field of usefulness is restricted to regions isolated from railroad communication by sparseness of population and by scanty resources for producing traffic. Artificial waterways provided for regions so situated cannot even be maintained by the revenue from their use. They can only exist as a permanent charge upon the public treasury for the benefit of the few who profit by them.

The President. (In French.) — I will request Mr. Colson to read out the proposed conclusions and as there are amendments, I propose to take them clause by clause. If any members have further amendments to propose I request them to let me have them at once.

Mr. Colson. (In French.) — I think that what was said a little while ago should not result in any modification of the proposed conclusions. The opinion has been expressed that in America the canals have not been able to stand the railway competition. While fully admitting this to be the case, it is none the less true that the waterways are sometimes competitors of railways.

These are the conclusions which are put to the vote :

" The Congress notes that waterways as a rule play a much more important part as competitors than as feeders of railways. "

" The factors which influence the division of the traffic between the two ways are as follows..."

Mr. Fairfax Harrison proposes to insert, after the words " feeders of railways ", the words " in the United States, however, experience proves that canal competition cannot be serious ".

I see no objection to the adoption of this addition.

If there are no further remarks, the first paragraph, as amended, will then run as follows :

" The Congress notes that waterways as a rule play a much more important part as competitors than as feeders of railways; in the United States, however, experience proves that canal competition cannot be serious. The factors which influence the division of the traffic between the two ways are as follows..."

— This first paragraph is adopted.

Mr. Colson. (In French.) — The second paragraph of the conclusions runs as follows :

" 1° *Rates*, which are, generally, lower by water than by rail; this is more especially due to the fact that railway rates are fixed so as to remunerate the capital spent on construction as much as possible; on the other hand, as regards waterways, States sometimes supply capital and attend to the maintenance without remuneration, or else are satisfied with collecting tolls which only exceptionally cover the cost of maintenance; only in England is the contrary the case, and there inland water carriage over long distances has become very rare. In spite of the advantage granted everywhere else to their competitors, railways, when free to modify their rates for the traffic which is competed for, without granting other classes of traffic reductions in rates incompatible with the charges incurred, can easily lower their rates without losing all their profit, and make cheaper rates than those obtainable on smaller waterways, with many locks and numerous curves. Only with difficulty do they reduce their rates to the level of the freights charged on large rivers with a gentle gradient, well regulated and provided with the necessary equipment, as in the case of the Rhine and the Volga; and their rates always remain higher than the freight on the great lakes which are similar to inland seas."

— Adopted.

" 2° *Terminal charges*, which have a notable influence on the choice between the two ways, when only one of them is in direct connection with the establishments of the consignors or the consignees, either because these are located on the banks of the waterways, or because a private siding connects them with the railway. This factor is decisive in the case of short distances; competition begins at medium distances, and the railway gains or loses influence, as the distance increases, according to whether the tariff is a differential one, or whether on the contrary it remains practically proportional to the distance."

— Adopted.

" 3° *The time required for the journey*, which is much less on the railway, except in the case of relations where the econom-

ical and geographical situation of the waterway makes it possible to use powerful steam-engines; on the other hand, water-carriage is nearly everywhere subject to interruptions which do not affect railways."

— Adopted.

" 4° *The nature of the goods*, which resist more or less well the effects of water-carriage. It is by no means correct (as is often said) that the line of separation is formed by the value; water-carriage is used for goods of a rather considerable value per ton, when technical and commercial conditions make a regular service possible; its disadvantages are then counter-balanced by the relatively high rate which railways charge for such goods; railways, on the other hand, can carry large consignments of heavy goods at as cheap a rate as the waterway, on lines of easy profile serving the same relations. The objections to the longer time required for the journey, and to the effects of damp, may be as important for low-price goods (coal) as for more valuable articles."

— Adopted.

" 5° *Direction of traffic at seaports.* — Waterways take away from railways a larger fraction of the import traffic than of the export traffic, especially while regulations and public opinion prevent railways from applying the same reduced rates to imports as to exports and also because direct transhipment from ship to lighter is easier for oversea goods carried in large quantities by sea than for home produce which generally arrives in small quantities from various parts of the country, to be shipped when a ship is available."

— Adopted.

" 6° *Variations in the activity of the traffic*, due to the season or to economical crises. The railway has much more flexibility in meeting sudden changes. Variations in the activity of business produce, in the case of railways, large variations in the amount of traffic offered; these only in very exceptional cases cause alterations in the rates. On the other hand, the waterways retain a less variable tonnage of the traffic competed for, by raising or lowering their rates according to the state of the market.

" Next considering the position of waterways as feeders of railways, one sees that if the latter were able to modify their rates at their own convenience, they would nearly always be able to carry consignments the whole way, giving the public as favourable conditions as mixed carriage would, while at the same time realizing a higher profit to remunerate their capital.

" A railway administration has not much interest in cooperating with inland waterway services (unless these are of a quasi-marine character) except in three cases :

" 1° When railways are prohibited from making lower rates so as to retain the traffic for the whole distance, as is, generally, the case with imports;

" 2° When their lines are able either to receive from waterways or to bring to them traffic which might be carried the whole distance by a rival railway;

" 3° When in a country where the railway system does not yet provide for all

important currents of traffic, as in Russia, the State was wise enough to connect first by means of railways the centres not already connected by waterways, so that a mixed route is the only one possible for many articles.

" If it is necessary to establish a new line to provide for a considerable flow of traffic, for which existing lines do not suffice, and if the topographical and economic conditions would make an artificial waterway possible, the same result can be obtained with less expenditure by constructing a railway."

Mr. Franke. (In German.) — I propose a slight alteration at the end of the last paragraph, in order to make full allowances for peculiarities resulting from local conditions. The wording proposed is the same up to the words " the same result ", and then the continuation should be replaced by " can be obtained by constructing a railway, costing less for construction and operation; particular cases being of course excepted."

Mr. Colson. (In French.) — We have no objection to the proposed addition; we have taken care, while recording the technical superiority of railways as a rule, to mention that there are special cases where navigation can encounter specially favourable conditions which will make it cheaper.

— The conclusions, with the amendment proposed by Mr. Franke, are adopted.

Mr. Colson. (In French.) — There still remains the additional paragraph proposed by Mr. Timonoff. It runs as follows :

" It is desirable that in all countries where inland navigation plays or can play an important part, the study of the reciprocal influence of waterway and railway carriage should be carried out in a continuous and systematic manner, in accordance with a programme drawn up by the Permanent Commission of the Railway Congress, acting conjointly with the Permanent Commission of the Navigation Congress."

Mr. Franke. (In German.) — I propose to word this paragraph as follows :

" It is desirable that in all countries where inland navigation has played or can play an important part, the study of the reciprocal influence of waterway and railway carriage should be made in a continuous and systematic manner. From this point of view, it is advisable that a programme should be drawn up by the Permanent Commission of the Railway Congress, acting conjointly with the Permanent Commission of the Navigation Congress."

Mr. Timonoff. (In French.) — I agree to this alteration in the wording.

— The last paragraph, thus amended, is adopted.

DISCUSSION AT THE GENERAL MEETING

Meeting held on 14 July, 1910 (afternoon).

MR. P. WEISSENBACH, PRESIDENT, IN THE CHAIR.

GENERAL SECRETARY : MR. L. WEISSENBRUCH.

FIRST ASSISTANT GENERAL SECRETARY : MR. MÜRSET.

SECOND ASSISTANT GENERAL SECRETARY : DR. A. BONZON.

Mr. Bloch, *principal secretary of the 4th section*, read the

Report of the 4th section.

(See *Journal de la huitième session*, No. 5, p. 5.)

" Mr. MARLIO, in his own name and in that of Mr. Colson, set forth the principal points of their joint report. He described the relative situations of the railways and the waterways in the different countries, and emphasized the advantage the latter had of freedom from toll. He examined in succession : the cost of carriage on boats, the influence of the terminal charges, that of the system of rating of the railways on the division of the traffic between the two classes of ways, and he mentioned the other causes which could affect this division : time required for the conveyance, nature and value of the goods, class and habits of the customers, influence of large centres. He demonstrated more especially the error of the opinion, too readily accepted, that water-carriage was limited to heavy goods. He showed how river navigation facilitated the importation of foreign produce and how shipping, not readily increased and with very variable rates, generally left to the railways the burden of any excess traffic during times of over-production.

" The direct competition of railways would be easy with defective or even medium-quality waterways if it did not too frequently meet with the opposition or at least the excessive requirements of the public authorities, who in certain countries however authorized special agreements, between railways and the users of waterways. Such competition could often be made indirectly against good waterways by limiting through suitable tariffs the zone of reconsignments at the transhipports.

" Cases of cooperation of railways and waterways were very rare.

" This interesting report was supplemented by an examination of the net cost of carriage of goods in large quantities on railways; it showed that this was 1 to 1·2 centime per ton-kilometre (0·157*d.* to 0·188*d.* per English ton-mile).

" Mr. JEBB (*reporter*) set forth that in England only the Birmingham canal carried an important traffic; it served as feeder to the railways. The demands for the construction of new waterways would meet with but little response owing to the certainty of a deficient return on the capital expended and the probable refusal of any financial assistance from the State or the local authorities.

" Mr. COLSON gave a summary of Mr. W. E. Hoyt's report, as he was absent. According to this report, the very low rates of American railways took away all importance from inland navigation, which had lost its former importance both on the Erie canal and the Mississippi river. The State of New York had however undertaken to enlarge the Erie canal at a cost of over 100 million dollars (£20 millions).

" During the ensuing discussion Mr. MERCZYNG (*Russian State Railway*) drew attention to the regularizing of navigation by means of mechanical traction; Mr. TIMONOFF (*Russian government*) desired that an investigation should be made, jointly with the International Congress of Inland Navigation, on the comparative merits of railways and waterways; Mr. RICHÉ (*French Eastern Railway*) thought that such an understanding would be impossible; Mr. COLSON thought that such an investigation, by two opposing parties, would be useful in order to give partisans of navigation an opportunity for stating precisely the reasons for the superiority which they claimed; Mr. HALE (*American Railway Association*) urged that the stress of times of too much traffic fell exclusively on railways; Messrs. W. E. HOYT (*reporter*) and HAINES (*government of the United States of America*) thought that the competition of waterways with railways was impossible owing to the low rates of the latter.

" Finally Mr. COLSON read his proposed conclusions, which were slightly modified to meet remarks by Messrs. Fairfax HARRISON (*Southern Railway, United States of America*) and FRANKE (*Prussian State Railway*), and then were adopted by the 4th section in the following form."

The President. (In French.) — The following are the

CONCLUSIONS.

" The Congress notes that waterways as " a rule play a much more important part " as competitors than as feeders of rail- " ways; in the United States however, " experience proves that canal competi- " tion can not be serious. The factors " which influence the division of the " traffic between the two ways are as " follows :

" 1° *Rates*, which are generally lower " by water than by rail; this is more " especially due to the fact that railway " rates are fixed so as to remunerate the " capital spent on construction as much " as possible; on the other hand, as " regards waterways, States sometimes " supply capital and attend to the main- " tenance without remuneration, or else " are satisfied with collecting tolls which

" only exceptionally cover the cost of " maintenance; only in England is the " contrary the case, and there inland " water carriage over long distances has " become very rare. In spite of the " advantage granted everywhere else to " their competitors, railways, when free " to modify their rates for the traffic which " is competed for, without granting other " classes of traffic reductions in rates " incompatible with the charges incurred, " can easily lower their rates without " losing all their profit, and make cheaper " rates than those obtainable on smaller " waterways, with many locks and nume- " rous curves. Only with difficulty do " they reduce their rates to the level of the " freights charged on large rivers with " a gentle gradient, well regulated and " provided with the necessary equipment, " as in the case of the Rhine and the " Volga; and their rates always remain " higher than the freight on the great " lakes which are similar to inland seas.

" 2° *Terminal charges*, which have a " notable influence on the choice between " the two ways, when only one of them is " in direct connection with the establish- " ments of the consignors or the con- " signees, either because these are located " on the banks of the waterways, or " because a private siding connects them " with the railway. This factor is decisive " in the case of short distances; com- " petition begins at medium distances, " and the railway gains or loses influence, " as the distance increases, according to " whether the tariff is a differential one, " or whether on the contrary it remains " practically proportional to the distance.

" 3° *The time required for the journey*, " which is much less on the railway, " except in the case of relations where the " economical and geographical situation " of the waterway makes it possible to " use powerful steam-engines; on the " other hand water-carriage is nearly " everywhere subject to interruptions " which do not affect railways.

" 4° *The nature of the goods*, which " resist more or less well the effects of " water-carriage. It is by no means " correct (as is often said) that the line " of separation is formed by the value; " water-carriage is used for goods of a " rather considerable value per ton, when " technical and commercial conditions " make a regular service possible; its " disadvantages are then counter-balanced " by the relatively high rate which rail- " ways charge for such goods; railways, " on the other hand, can carry large con- " signments of heavy goods at as cheap a " rate as the waterway, on lines of easy " profile serving the same relations. The " objections to the longer time required " for the journey, and to the effects of " damp, may be as important for low- " price goods (coal) as for more valuable " articles.

" 5° *Direction of traffic at seaports.* — " Waterways take away from railways a " larger fraction of the import traffic than " of the export traffic, especially while " regulations and public opinion prevent " railways from applying the same reduc- " ed rates to imports as to exports and " also because direct transhipment from " ship to lighter is easier for oversea " goods carried in large quantities by sea " than for home produce which generally " arrives in small quantities from various

" parts of the country, to be shipped when " a ship is available.

" 6° *Variations in the activity of the* " *traffic*, due to the season or to econom- " ical crises. The railway has much " more flexibility in meeting sudden " changes. Variations in the activity of " business produce, in the case of rail- " ways, large variations in the amount of " traffic offered; these only in very " exceptional cases cause alterations in " the rates. On the other hand, the water- " ways retain a less variable tonnage of " the traffic competed for, by raising or " lowering their rates according to the " state of the market.

" Next considering the position of " waterways as feeders of railways, one " sees that if the latter were able to " modify their rates at their own con- " venience, they would nearly always be " able to carry consignments the whole " way, giving the public as favourable " conditions as mixed carriage would, " while at the same time realizing a " higher profit to remunerate their ca- " pital.

" A railway administration has not " much interest in cooperating with " inland waterway services (unless these " are of a quasi-marine character) except " in three cases :

" 1° When railways are prohibited " from making lower rates so as to retain " the traffic for the whole distance, as is " generally the case with imports;

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" 3° When in a country where the rail- " way system does not yet provide for all " important currents of traffic, as in " Russia, the State was wise enough to " connect first by means of railways the " centres not already connected by water- " ways, so that a mixed route is the only " one possible for many articles.

" If it is necessary to establish a new " line to provide for a considerable flow " of traffic, for which existing lines do " not suffice, and when the topographical " and economic situation would make an " artificial waterway possible, the same " result can be obtained by constructing " a railway, costing less for construction " and operation; particular cases being of " course excepted.

" It is desirable that in all countries " where inland navigation has played or " can play an important part, the study of " the reciprocal influence of waterway " and railway carriage should be made in " a continuous and systematic manner. " From this point of view, it is advisable " that a programme should be drawn up " by the Permanent Commission of the " Railway Congress, acting conjointly " with the Permanent Commission of the " Navigation Congress."

— These conclusions were confirmed by the general meeting.

SECTION IV : GENERAL

[313 .385. (01]

QUESTION XIV

STATISTICS

A. *Principles of statistics of railways in operation.*
B. *Uniform classification of working expenses.*

Reporters :

Great Britain. — Mr. W. M. Acworth, of London.

British colonies. — Sir Thomas Rees Price, general manager, Central South African Railways.

America. — Mr. A. J. County, assistant to second vice-president, Pennsylvania Railroad

Other Countries. — Mr. Barriol, chief of division, Paris-Lyons-Mediterranean Railway.

QUESTION XIV

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Report No. 1 (British colonies), by Sir Thomas Rees Price. (See English edition of the *Bulletin* of December, 1909, p. 1569.)	XIV — 3
Report No. 2 (Great Britain), by Mr. W. M. Acworth. (See English edition of the *Bulletin* of January, 1910, p. 3.)	XIV — 87
Report No. 3 (all countries, except Great Britain, British colonies and America), by Mr. Barriol. (See English edition of the *Bulletin* of May, 1910, p. 2049.)	XIV — 133
Report No. 4 (North America), by Mr. A. J. County. (See English edition of the *Bulletin* of June, 1910 [2nd part], p. 2985.)	XIV — 161
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N. B. — Vide also the separate issues (in red cover) Nos. 15, 23, 50 and 62.

[313 .385. (01]

REPORT N° 1

(British Colonies)

By Sir THOMAS R. PRICE, K. C. M. G.,
GENERAL MANAGER, CENTRAL SOUTH AFRICAN RAILWAYS.

CONTENTS.

1. — *Memorandum by reporter and introduction.*

2. — *Principles of statistics of railways in operation.*

- *a*) General.
- *b*) Accounts.
- *c*) Statistics of physical condition of property and equipment.
- *d*) Statistics of volume and character of traffic carried.
- *e*) Unit statistics as applied to volume of traffic carried, etc.
- *f*) Statistics of cost of operation.
- *g*) Statistics relating to indirect and subsidiary services.
- *h*) Miscellaneous other statistics.

3. — *Uniform classification of railway working expenses.*

4. — *Conclusions of reporter.*

5 — *Annexures.*

PART 1.

Memorandum by reporter relative to question XIV (II of section 4).

Railways have become so important a factor in human affairs as almost to warrant the general statement that the progress and prosperity of any country depends on the extent and rate of increase of that country's railway communications and on the wisdom or otherwise of their administration. Any measures which conduce to true efficiency and economy, undoubtedly lead to the extension or extended use of such means of transport.

One of the most valuable aids to efficient management is afforded by comprehensive, well-balanced statistics and accounts, especially if they are available in time to serve the purpose of a guide to current matters. Belated figures usually serve only for purposes of record or criticism; they lose much of their value to the Administration, by reason of their failure to bring promptly to notice the warnings or suggestions which the figures convey.

Since all progress is relative, it is desirable that such statistics and accounts should afford comparisons with other periods or other systems or both, and as it is the case that the main problems connected with commercial railway working (though differing in matters of detail) are more or less the same in nearly all countries, it is clear that the adoption by all railways of uniform methods of recording their statistics and results of working would prove of inestimable value in railway management and administration.

One of the most lasting impressions derived by the writer while on a tour of the various British Colonies, Japan, the United States, Great Britain, and the continent of Europe — an impression which was strengthened by a visit on a later occasion to Egypt and British East Africa — was this international similarity of problems relating to railways and harbours, and the regrettable absence of any system which would render the experience of one country sufficiently and readily available to the other. The possession of such information would over and over again have meant the saving of large sums of money, and would have ensured constantly increasing efficiency and progress. This conviction has only been deepened by subsequent experience and observation.

It is perhaps too much to hope for absolute uniformity in railway statistics in the immediate future since there is such great diversity in the statistical needs of the various railways in different parts of the world, but the discussion by the Conference of the principles of such statistics cannot fail to have a very powerful influence in the direction of securing greater uniformity and utility in the future than has been possible in the past.

So far as the classification of railway working expenditure is concerned, however,

the arguments in favour of uniformity are so convincing, and the advantages of being able to institute comparisons between one system and another are so pronounced as to compensate amply for any inconvenience and expense which would be entailed by changes in existing expenditure classifications. It is to be hoped that the deliberations of this Conference will result in the adoption of a recognised standard form of accounts and classification of expenditure for all railways at an early date.

The writer of this paper feels that he can best serve the purpose the Congress has in view by emphasising the importance of securing such uniformity. If, for the purpose of bringing into relief existing differences he has trespassed on the railway area entrusted to other reporters in order to contrast the practice of other countries with that of British Colonies, his doing so will, it is hoped, not be misunderstood.

INTRODUCTION.

Method adopted in preparation of papers.

In order to obtain information for a survey of the conditions obtaining at the present time in the British Colonies and Possessions, it was necessary to submit to the different Administrations a long series of questions dealing with the two branches of the subject of "Statistics". Information was sought in all from forty-one railways, and I have to express my very sincere thanks to the officers engaged in their administration for the large amount of time and trouble taken by them in furnishing the exhaustive information contained in their replies. Particulars of the railways from which information was sought and the extent to which such Administrations have been able to accede to my request for particulars of their practice, are given in the following table.

As might be expected, the railway systems in the British Colonies have in the main followed British practice in regard to the preparation of statistical data, and also in the classification of their working expenditure.

In most cases, such railways are the property of the Government, or the Government has entrusted their operation to a company for a term of years, but retains such a large amount of control in the meantime as to leave the influence of State ownership practically untouched. The capital required for the construction of the lines was in almost every case raised in Great Britain, and the staff was, at the outset, mainly drawn from English railways.

The Governments of the Colonies concerned in the construction of railway lines would, in the first instance, naturally adopt the expenditure heads laid down by Parliament for English railways, rather than frame special heads of their own. With this classification, the staff would be familiar by reason of their English training, and their adherence to it would be a matter of habit. Occasionally, special or local circumstances would imperatively demand some departure from the recognised model, in the shape perhaps of a new sub-head or item of expenditure which did not fit in with the English classification, or publice opinion (somtimes expressed

in Parliament, sometimes outside of it) would demand a more detailed classification to admit of more efficient control being exercised.

Of late years, other potent factors have been at work in bringing about modifications of the original type of classification in the colonies.

In the preparation of the attached papers, the writer has naturally been influenced to a considerable extent by South African practice and particularly by methods followed on, and experience derived from the administration of, the Central South African Railways.

In the case of these latter railways, economical working is of especial importance, for the two Colonies they serve (*viz.*, the Transvaal and the Orange Free State) are a long way from the coast, and there is an entire absence of navigable waterways or other means of reliable and cheap transport apart from railways. Consequently, the aids rendered by statistics and other means have been largely availed of. Advantage has also been taken to the utmost possible extent of the experience of other countries in deciding upon the accounts and statistics calculated to best meet the requirements.

The system of accounts at present adopted by the Central South African Railways is partly based on that of the Buenos Ayres Great Southern Railway of South America (which was itself adopted, it is understood, on the advice of a leading firm of British Chartered Accountants) and partly on the classifications issued by the United States Inter-State Commerce Commission, with the addition of French, British, and colonial elements where such seemed well adapted to local conditions.

In analysing the replies received and the information contained in the printed reports received from the different Colonial Railway Administrations, an attempt has been made to adhere, as far as possible, to the subdivisions given in the list of subjects furnished by the Congress, *viz.* :

A. — Principles of Statistics of Railways in operation;
B. — Uniform Classification of Working Expenses.

But it is obviously difficult to draw a hard and fast line between two branches of a subject so closely related, and in order to facilitate separate treatment, a certain amount of repetition has been unavoidable.

List of the British Colonial Administrations to which papers of questions were sent showing those from which replies were received.

ADMINISTRATION.	NAME OF RAILWAY.	Replied to questions.	Furnished reports only.
India and Burma	Bengal and North-Western Railway	...	...
	Bengal Nagpur Railway	...	...
	Eastern Bengal State Railway	1	...
	East India Railway	1	...
	North-Western Railway	...	...
	Oudh & Rohilkhand Railway	...	1
	Great India Peninsula Railway	...	...
	Madras & South Mahratta Railway	...	...
	South Indian Railway, Limited	...	1
	Southern Punjab Railway, Limited	...	...
	Assam Bengal Railway Company, Limited	1	...
	Bengal Central Railway Company, Limited	...	...
	Bombay Baroda & Central Railway	...	1
	H. E. The Nizam's Guaranteed State Railway	...	...
	Burma Railways, Limited	...	1
Ceylon, Malay States and Borneo	Ceylon Government Railway	1	...
	Federated Malay States Railways	1	...
	British North Borneo Government Railways	...	...
South Africa	Cape Government Railways	1	...
	Central South African Railways	1	...
	Natal Government Railways	1	...
	Beira and Mashonaland Railways, Limited	...	...
	Rhodesia Railways	...	...
East Africa	Uganda Railways	...	...
West Africa	Lagos Government Railways	...	...
	Sierra Leone Government Railways	1	...
	Gold Coast Government Railways	...	...
Mauritius	Mauritius Government Railways	...	...
Mediterranean Colonies	Cyprus Government Railways	1	...
	Malta Government Railways	...	1
Australasia	Queensland Government Railways	...	1
	New South Wales Government Railways	1	...
	Tasmania Government Railways	...	1
	New Zealand Government Railways	...	1
	South Australia Government Railways	...	1
	Victoria Government Railways	...	1
	West Australia Government Railways	...	1
South America and West Indies	Trinidad Government Railways	1	...
	Barbados Light Railways, Limited	...	...
	Demerara Railway Company	...	...
	Jamaica Government Railways	...	...
		12	11
	[Total . . . . . 41]	Total. . .	23

PART 2.

Principles of Statistics of Railways in operation.

a) General.

To the older railway official, few things are more noticeable than the change which has taken place in recent years in the attitude of those engaged in the business of transportation in regard to railway statistics, and the increasing recognition there now is of the value of such statistics as a means of securing the best results in working. Formerly, statistics were regarded as particularly useful in bringing about reductions of staff and in indicating possible economies in other directions, the effecting of such economies being regarded as an end in itself rather than as a means to an end.

At the present time, the value which such statistics of operation possess in securing economical working is still omitted, but more adequate recognition is accorded to the possibilities which any reductions in cost (or increases in efficiency) open up in the way of increased traffic and increased employment of staff. More importance is therefore now attached to statistics of traffic carried, and other figures likely to indicate directions in which expansion is possible.

In this connection, it is necessary to remember that of the total revenue earned by an average railway approximately 40 per cent is required to meet charges such as interest (or dividends) on capital. Of the remaining 60 per cent, authorities differ as to the average proportion consisting of expenditure which can be readily adjusted to any variation in the traffic offering, as distinct from what may be regarded as fixed operating charges (such as the cost of absolutely necessary material for maintenance or up-keep and the pay of such of the Executive and Administrative Staff, Station, Locomotive, Permanent Way, Stores, and Accounting Staff, as must be employed and paid irrespective of the conditions of trade), but one-half may be taken as a fair approximate average. That is to say, the scope for effecting economies in working expenditure does not, on the average railway, usually exceed 30 per cent of the gross receipts — the rest of the expenditure is more or less beyond the control of those entrusted with actual operation.

This aspect of the question serves to emphasise the advantage of seeking to secure improvements in financial working results by encouraging the development of such traffic as statistics show to be of a profitable nature.

Object of preparation of railway statistics.

The object of preparing statistics of railway operation should, in the opinion of the writer, be regarded as fourfold :

1° To present a clear idea of the general physical condition of the property;

2° To give full information as to the transportation services rendered and the remuneration received for such services, with a view to indicating directions in which it is possible to foster traffic;
3° To indicate the cost of doing the work and the directions in which it is possible to reduce such cost without detriment to efficiency;
4° To indicate the social and economic aspects of operation as affecting the public in general and the staff employed in particular.

Accounts and statistics : relation between.

While it is true that the figures recorded in the accounts of a railway form an important section of the statistics necessary for efficient administration and are the basis of some of the other statistics as well, it is the opinion of the writer that a clearer distinction than is usually made should be observed between the respective spheres of accounts and statistics, and in this paper an attempt has been made to separate matters of accounts from those statistics which are usually prepared for the special assistance and guidance of operating officers.

The latter class of statistics may be aptly divided into two sections, *viz.* :

1° Temporary;
2° Permanent.

Temporary statistics.

The temporary statistics are in a measure approximate, and consist of details obtained from day to day or from week to week, to guide the officer while operations are in actual progress — as examples the following are given :

Statements of approximate weekly earnings;
— of (received) traffic on hand at stations (daily);
— of traffic requiring transport in through and in local service (daily);
— of train loads (tonnage) in comparison with haulage capacity of engines (daily);
— of weight of traffic in vehicles in comparison with capacity of such vehicles (weekly or monthly);
— of train and vehicle mileage (weekly);
— of train and wagon miles per engine hour (weekly or monthly);
— of trucks under load at stations (daily);
— of rolling stock on hand (daily).

Note. — In connection with such statistics, it is of interest to note that the controversy some few years ago as to the relative merits of ton mileage statistics (as compared with the particulars on which English railway managers relied) was probably due to the failure to recognise the necessity for temporary statistics. The value of properly prepared ton mileage records is, in the writer's experience, undoubted. But at best the records can only be available some time after the traffic has been carried, and in the meantime, the needs of the operating officials require to be met by means of temporary statistics.

Permanent statistics.

The permanent statistics, on the other hand, comprise actual ascertained results collected and presented as early as may be possible for scrutiny, enquiry, and consideration after the operations are over. These statistics are especially valuable if they enable comparisons to be usefully made with earlier periods or with results attained on other lines. If the interval between the operations they record and the time of their presentation is not long, they are extremely valuable to the Administration as a record of what has been accomplished. They often also indicate directions in which it is possible to attract profitable trade and to curtail avoidable expenditure, without sacrifice of efficiency. If judiciously prepared and well balanced, they are especially valuable in enabling the Administration to form a judgment in regard to such matters as proposals for additional facilities to the public using the railway, inasmuch as they serve to indicate whether such additional services will be remunerative or not.

They should also be concise and to the point, for as a rule, the administrator of a railway has the current operations of his lines to attend to, and gets but little leisure time in which to digest voluminous statements. What is placed before him should render it possible for him to take a survey of the month's operations and take cognisance of any salient features without the expenditure of much time.

To secure this, it is essential that the preparation of such statistics should be entrusted to trained officers who fully recognise that their purpose is not so much to serve criticism as to guide and help the administrators in their work of supervising operation — work which is at best both arduous and harassing.

It is scarcely necessary to add that those on whom the duty of preparing or scrutinising the figures rests should be keenly alive to the importance of bringing to notice facts which indicate possibilities of increasing the traffic of the lines or securing better results of operation or increased comfort and contentment of the travelling public and the railway staff.

Similarly it goes almost without saying that one set of statistics, however valuable, without the corrective supplied by others, cannot fail to lead astray. For instance, statistics based on train mileage alone may often give an impression which is at variance with actual facts, and ton mileage statistics are themselves of limited value without figures of train mileage, earnings, tonnage of traffic (and its direction) at certain principal stations or districts. Such figures must be supplemented also by knowledge of traffic and working considerations, which can only be partly expressed in statistics.

Subject to the foregoing general observations, a somewhat detailed analysis of the principles on which the statistics prepared on British Colonial railways are based, together with information as to the statistics which the experience of the working of the railways under the charge of the Reporter, has indicated as the most suitable, is submitted for the consideration of the Congress.

b) Accounts.

The construction and equipment of a railway involves considerable expenditure. It is essential that proper records should ke kept of the money raised for, and the expenditure involved in, bringing the line up to the stage when it begins to earn revenue and in carrying out any subsequent extensions or substantial improvements. It is equally important when the line is opened that proper accounts should be kept of the earnings from operation and of the working expenditure, interest, and all other charges, as well as of the resulting profit or loss, as the case may be.

As has already been pointed out, the accounts of a railway form the foundation of much statistical data, and the importance of securing, at the outset, such a uniform system of accounts as will readily admit of the preparation of such statistical data is worthy of careful consideration.

Nature of railway capital expenditure.

If the items of capital expenditure in connection with railways are analysed, it will be seen that they fall under fairly well defined heads, namely :

1° Permanent way, works, and accessories (including station buildings);
2° Equipment : engines and rolling stock;
3° General buildings, workshops, offices, stores, etc.;
4° General expenses and cost of raising capital.

In addition to the above there is, in the case of many railways, capital expenditure in connection with such outside operations as docks and wharves, hotels, grain elevators, etc., which should be kept distinct from railway capital expenditure proper.

Form of capital account.

The Capital Accounts of very few colonial railways give particulars of capital expenditure. Sometimes, however, the capital cost of each of the different sections of the line is shown, such items of capital expenditure as are common to one or more sections being pro-rated on some arbitrary basis.

While the desirability of keeping records of capital expenditure under sections cannot be questioned, it appears to the writer that such sectional records should be subordinate to the main statement of capital expenditure, which would show the totals of the different items making up the cost of the railway system (such as permanent way, works, equipment, etc.) in such order as will facilitate analysis under sections.

In considering to what extent records in detail should also be kept of the cost of particular works, equipment, and appliances, regard should be had to the fact that, notwithstanding the most liberal provision for maintenance and repair, capital assets of almost every nature, except land, are subject to deterioration, and if the capital account of an administration is to remain accurate, it is absolutely necessary to keep proper records of the cost of each class of such assets. By this means only can the necessary adjustment be made when the asset goes out of service or is condemned.

Balance-sheet.

That comparatively few British Colonial railways prepare a regular " Capital Account " and " Balance-Sheet " showing their financial position, is probably due to the finances of the railways being more or less intimately bound up with those of the colony itself. The value of such statements in connection with the study of railway working is so considerable, that the writer is induced to subjoin draft specimens (1) of forms based on accounts actually prepared in British Colonies, so as to bring under discussion the question of the standardisation of railway accounts and returns of this nature.

In the case of many British Colonial railways, the complete adoption of standard forms would not be possible without more or less divorcing railway accounts from the ordinary Goverment accounts, but on the Central South African Railways, this step has been taken with results which leave nothing to be desired, either from the standpoint of the Government or the Railway Administration.

Revenue account and net revenue account.

The importance of setting out clearly the earnings and expenditure of lines open for traffic is generally recognised throughout the British Colonies, but unfortunately there is a want of uniformity in the manner of doing this. To begin with, there is no common understanding as to the heads under which either earnings or expenditure shall be kept. In some cases, earnings are made to include the receipts from departments worked by the railway which are not strictly a part of the ordinary services of transportation. Again, some Administrations show under " Earnings " only *cash actually received* (a practice adopted from English Government accounts), while others, correctly, record their whole earnings, whether such earnings have been actually received or not.

In regard to the recording of expenditure, similar diversity of practice exists, and will be dealt with in detail later on in the course of this paper.

No uniformity can be attained and no useful comparisons can be instituted between one railway and another, unless some general principles are adopted which will eliminate at any rate the most serious differences in present practice. The following proposals are submitted for consideration :

1° That each Administration should keep a " Revenue Account ", which would be *credited* under suitable heads with amounts earned (whether collected or not) for services directly and necessarily connected with transportation by rail; *debited* under suitable heads with the cost (whether actually paid or not) of maintaining the railway and the equipment, of working the traffic, of management, and of other services directly and necessarily connected therewith.

2° That each Administration should keep a " Net Revenue Account " and an

(1) See part 5.

" Appropriation Account ". These accounts would be dealt with as follows :

NET REVENUE ACCOUNT would be credited with the gross profit over working expenses (brought from the " Revenue Account " referred to in 1° above) and would also be credited or debited with the following items according as same represent profit or loss :

a) Net profit or loss on lines leased.

b) Net profit or loss on working of Cartage Department, Catering Department and Hotels, Steamer Services, Tramway Services, Bookstalls, House Property, Other separate Departments which are in the nature of outside investments.

c) { Interest earned on investments (Credit).
{ Interest paid on fixed Railway Loans (Debit).

d) Bad debts and losses written off (Debit).

APPROPRIATION ACCOUNT would be *credited* with :

1° The balance of net Profits shown in the Appropriation Account for the previous year.

2° The profit for the current period as shown in the Net Revenue Account above referred to.

It would be *debited* with any amounts appropriated from profits for such purposes as.

a) Improvements of railway property;

b) Redemption of Capital or Loans;

c) Acquisition of new Capital Assets (capital expenditure from profits);

d) Dividends to Shareholders.

3° That any refunds of revenue should be deducted from the revenue affected and not be shown as expenditure.

4° That any expenditure of a recoverable nature should not be included as part of the expenditure shown in the Revenue Account or the Net Revenue Account but debited to a Suspense Account pending recovery.

5° That where rolling stock is hired from or loaned to another administration, on payment, the net earnings or expenditure only should be shown in Revenue Account.

6° That expenditure on such services as relaying large sections of a line, replacing buildings, renewals of locomotives and rolling stock, should either be provided for out of Renewals Funds created and maintained by the inclusion in the working expenditure accounts of regular charges for depreciation (preferably under a separate head or separate sub-heads) or should be recorded separately under each head of working expenditure shown in Revenue Account.

7° That any revenue represented by charges raised for haulage of the administration's stores and material over home lines should be shown separately in Revenue Account and not included under the ordinary heads of traffic earnings. The advantage of creating debits for all such services as a check upon unnecessary haulage is undoubted.

Specimen forms of Revenue, Net Revenue and Appropriation Accounts which will serve to explain more clearly what is suggested are attached (1).

EARNINGS.

The main sources of railway revenue are

a) the transport of passengers (with their luggage) and goods (including live stock and minerals).

b) Other services not so directly connected with transportation—such as storage, cloakroom receipts, etc.

Such a division of earnings would be inadequate for any except the very smallest administration. It is somewhat important, however, that it should form the basis of any more extended classification, since it distinguishes clearly between those earnings arising directly from the conveyance of traffic and those which are more or less incidental thereto.

Classification of traffic earnings.

A logical method for the further subdivision of transportation earnings is indicated by the different quality of the services rendered in connection with the conveyance of the traffic. Passengers, their luggage, mail matter, and parcels are usually carried in trains running at higher rates of speed; the stations and vehicles provided are usually of more costly construction and both earnings and expenditure in connection with the traffic are high in comparison with those for the conveyance of other traffic.

If any idea at all of the relative profitableness of the different classes of work done by an administration is to be obtained the accounts should record separately the receipts for services performed by passenger trains as distinct from goods trains.

Then again, the earnings of goods trains must be subdivided where the traffic is at all large, the extent of the subdivision varying according to the nature and volume of the traffic carried. Differences in the vehicular accommodation provided and the existence in one case, and absence in another, of special expenses in connection with conveyance would suggest as natural the following subdivision of the goods earnings :

a) Live stock;

(1) See part 5.

b) Goods;
c) Minerals.

Classification of earnings incidental to traffic.

The subdivision of earnings from operations not so closely connected with the conveyance of traffic might quite well be effected so as to conform to the same general order as the subdivision of the previous main head, *i. e.* the first class would be earnings, which are more particularly connected with the coaching service and the second those earnings which relate rather to the goods service. A third subdivision would consist of those earnings which are quite general in character, and do not specially pertain to either the passenger or goods services.

EXPENDITURE.

Expenditure.

The second part of this paper deals with the classification of railway working expenditure, and it is only necessary to mention here such general principles as appear to be essential to the preparation of " unit " statistics (that is, statistics such as the cost of any particular service per ton, per open mile, per train mile, etc.).

A perusal of the replies received from the various Colonies makes it apparent that the uniform observance of a few cardinal principles in the classification of expenditure would not only be of general advantage as admitting of ready comparisons between one railway and another, but would give each Administration, at trifling cost, information as to the working of the lines controlled, which could otherwise only be obtained by the preparation of special returns or statements at considerable cost. Moreover, the adoption of such principles would render easier the preparation of other statistics of railway working.

The position of a railway is that it has transport to sell, and its interest lies in disposing of it in the manner best calculated to yield the largest net revenue, due regard being had to other considerations always present with a good seller.

To arrive at this result, it is obviously necessary to know, as accurately as may be possible, the cost of each service that goes to make up in the aggregate the performance of transport, and the preparation of such information can be much more accurately and readily obtained if expenditure is classified *according to the nature of the services rendered* and not according to departments. If this principle were adopted a clear distinction would be drawn between :

a) Services directly connected with railway working, *i. e.*, the service of transportation;
b) Services not directly connected with the actual service of transportation (such as cartage, catering, hotels, etc.)

On most railways from which replies have been received, subdivision of expenditure is effected according to departments (following the usual English practice). As radical changes have already been made in the organisation of certain British

Colonial railways. The position at the present time is that some services which are in one administration performed by one department are in another entrusted to quite a different department, and any comparisons between railways with different types of organisation are consequently rendered either impossible or misleading. As the classes of work to be done on railways are more or less the same all over the world, these seem to afford by far the best divisions of the expenditure. If adopted, they would give the following as the main heads of railway working expenditure :

1° Maintenance of the permanent way and works, bridges, station and other buildings used in connection with the operation of the line, fencing, telegraph lines, signals, etc.;
2° Maintenance of equipment, *viz.*, locomotives and rolling stock;
3° Transportation and Traffic : expenditure for working and supervising the traffic;
4° General Administration : charges common to all services connected with the working of the railway.

The subdivision of such heads of expenditure would be effected so as to reflect as far as possible the cost of the different services rendered, special importance being attached to grouping items and sub-heads according to the proximity of the service to the actual conveyance of traffic.

The same observations apply in respect to subsidiary services undertaken either to make transport more attractive to the buyer, or else to procure revenue in diminution of the cost of carrying out the work, (including such services as catering and refreshments and advertising at stations).

c) Statistics of Physical Condition of Property and Equipment.

Capital assets : Statistics of.

As has already been mentioned in connection with capital account, it is important that records should be kept of the principal capital assets of a railway administration, and it is desirable that any statistical data prepared from such records should give an idea of the condition and, if possible, the value of such assets. The greater number of the British Colonial railways recognise this, and give full particulars of the mileage owned and operated and the accessories and equipment used in connection with such operations. The amount of detail given varies with almost every administration, but an analysis of the various statements furnished appears to indicate the desirability of compiling periodically the following information :

Permanent Way and Accessories.

General Statement, showing cost, length, highest point, steepest gradient, radius of sharpest curve, ruling gradient when fully compensated for curves, and average cost per mile of each line (excluding general workshops, general offices, and rolling stock).

Mileage Owned. — Statement showing separately the mileage of single, double, and treble track, and of sidings, also the equivalents in single track mileage for each section of the line.

Average Mileage Operated. — This information is required in connection with the preparation of other statistics.

Rails in Track. — Statement showing for each section the mileage of rails of each class according to weight, length, and date when laid.

Sleepers. — Statement showing for each section the mileage of each class of sleepers, the number laid to the mile, sizes, and ages.

Rail Fastenings. — Statement showing mileage of each type and ages.

Ballast. — Statements showing the mileage of each line according to the nature, depth, and width of the ballast used.

Bridges. — Dimensions, capacity, and cost on each section.

Reservoirs and Dams. — Particulars of capacity, description, number, site, and cost of construction for each section.

Pumping Plant. — Particulars of and cost for each section.

Coaling Plant. — Particulars of and cost for each section.

Station and other Buildings used for Railway Purposes. — Particulars for each section, under classes, giving cost.

Signalling Appliances. — Particulars for each section, under classes, giving cost.

Telegraph Lines and Instruments. — Particulars for each section, under classes, giving cost.

Land acquired for Railway Purposes. — Under sections, giving also cost and dimensions.

Equipment (Engines and Rolling Stock).

Locomotives, Particulars of. — Giving under separate types the following information :

Number of each type, tractive power, average weight (engine and tender in working trim), average cost per locomotive, dates when placed in traffic, condition, number of obsolete engines on hand. (Such statement should show against each type the additions and reductions during the period covered and particulars of any conversions. For any engines which have gone out of service the mileage run to date of condemnation should be stated for each class.)

Coaching Stock, Particulars of. — Giving for each description the number of vehicles, average age, average seating capacity, average tare, average cost. (Similar information as in the case of locomotives should be given as to additions and reductions, conversions, and mileage run by vehicles taken out of traffic.)

Goods Stock. — Similar particulars to those set out above for coaching stock (including average load capacity and average tare).

Workshops and other Plant and Machinery, Particulars of. — Giving description, age, and cost of plant owned; also of any additions or reductions during the period covered.

It is particularly important that, either in the above statements or in special statements, the condition of the equipment should be periodically brought under review. It is not sufficient indication of the actual position to show that there are so many engines and so many cars, unless the proportion or numbers in good, indifferent, or bad condition is also stated.

Statements of this nature (especially where condition and cost or value is given) exercise a salutary influence in securing that there shall be no long continuance of deterioration of capital assets, without the proper adjustments being made in capital account, or the assets being again placed in serviceable condition at the expense of working charges.

d) Statistics of the Volume and Character of the Traffic Carried.

Passengers: number and revenue.

Most railways give statistics of the numbers of passengers carried (usually also of the numbers availing themselves of each class of accomodation provided) and the revenue earned for their transport. Where the railway connects with the lines of other administrations, separate records are as a rule kept of the numbers and earnings in respect of the different classes of " through " (*i. e.* foreign) passengers exchanged with such other lines. Often also separate records are kept of the " up " and " down " passenger traffic.

The necessity for such statistics is self-evident. They enable those directing the services to gauge the public demand for facilities of different classes, and they afford information as to the probable financial and other effects of alterations in the scales of fares, in the types of vehicles used, and of any acceleration or increase of train service, etc.

To what extent particulars shall be kept will of course depend on the magnitude of the traffic carried. Some of the railways in the British Colonies keep statistics of passenger numbers under seven or eight heads, whilst others keep them all under one general head. The only rule which seems to admit of general application is that wherever there is a very considerable difference in the rates charged for conveyance of separate classes, it is advisable to keep separate records of the volume of traffic and earnings under each.

Luggage and parcels.

Luggage and parcels are usually carried by passenger trains, and in order that the earnings of the coaching service as distinct from the goods service may be ascertained it is desirable to keep separate records of the weight of such traffic for comparison

with the earnings. In many cases, separate records are kept of luggage and of parcels, and this information is sometimes found of particular value in connection with the arrangement of train services and the fixing or modification of luggage or parcels rates.

Other passenger train traffic.

Where mails, or such commodities as milk, are usually carried in large quantities by passenger trains, it may be necessary to keep a separate record of the weight and earnings under a special sub-head, but in the majority of cases all that would seem to be required is to have a general head under which miscellaneous revenue of passenger trains would be recorded with a view to arriving readily at the total earnings of such trains.

Goods and minerals.

What has been said with regard to coaching traffic, applies equally to traffic carried by goods trains or by goods vehicles on " mixed " trains. It is essential to efficient management and control that separate records should be kept of the tonnage of the most important commodities carried. If, against the tonnage of such commodities, the revenue earned can also be given the statements become still more valuable.

Traffic : direction of.

The importance of a distinction in the records between " through " and " local " traffic, and between traffic carried " up " or " down, " or " north " or " south " or " east " or " west " (as the case may be) of course varies with local circumstances, but in cases where the heavy traffic is in one direction, it is of undoubted value to have separate figures for the traffic in the two directions. Where there is the element of competition with other railways, it may be necessary or desirable to show separately the quantities and earnings of goods consigned to or from the areas where such competition is felt.

Commodities carried : classification of.

To suggest for general adoption by all administrations a detailed list of commodities, so that the tonnage of each carried might be stated in a uniform manner would no doubt be futile at the present time, but the writer would commend to the notice of those interested in the subject the general heads under which commodity statistics are prepared by all railways in the United States of America. The advantages in the matter of comparison of railway statistics if these or similar heads were adopted generally by railway administrations will be readily seen.

1° Products of agriculture;
2° Products of animals;
3° Products of mines;
4° Products of forests;
5° Manufacture and miscellaneous.

In the records of the Administration with which the writer is connected, the tonnage of and earnings on coal traffic (which in point of tonnage represents more than

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one half of the traffic) are shown under a separate head, entirely distinct from the figures of goods traffic and earnings (which latter include all minerals other than coal). While this practice may not be entirely suitable for other administrations, it would appear to be a matter worthy of consideration whether the adoption in railway accounts of a separate head of earnings for "Mineral Traffic" would not be of general advantage.

Another distinction that should be reflected in any tonnage statements is that between public traffic and railway service traffic.

c) Unit Statistics as applied to Volume of Traffic Carried, Traffic Earnings and Utilisation of Rolling Stock.

Statistical units.

To admit of the ready grasp of the meaning of figures showing the volume and earnings of passenger and freight traffic, as well as the expenditure connected with railway working, railway managers have long been in the habit of expressing the recorded results in terms of some unit, as an average or a percentage. As is natural, most railway units take into account the element of distance as well as that of weight or number. Thus we have units based on distance and

Equipment used	Train miles. Engine miles. Vehicle miles.
Number	... Passenger unit miles.
Weight	... Ton miles.

Train mileage.

An idea of the actual services performed in connection with the transportation of traffic is given by statistics of the train mileage run, but such information requires to be supplemented by other statistics, and by a general knowledge of working conditions before it can be put to much practical use. Train mileage figures are usually given for each of the two main divisions of traffic, *viz.*, coaching and goods, but in the case of large administrations the train mileage is subdivided into further classes. Under coaching train mileage, for instance, some administrations show separately the train mileage of fast and slow passenger trains, and the mileage of excursion trains. The extent to which subdivision is necessary depends, of course, on the individual requirements of each administration. The basis for division is indicated in most cases by some marked difference in the services rendered, or in differences in the expense of running particular classes of trains.

Most British Colonial Railway administrations make extensive use of the unit of train mileage in their records of operation. Usually the earnings, as a whole, are worked out per train mile ("up" and "down") for *a*) passenger trains and *b*) goods trains, but in some cases only, the average earnings per train mile are given without any distinction being drawn between the two services. Needless to say, the latter

information, while giving a general figure of considerable value, is inadequate except for small administrations. Where the train mile earnings for coaching traffic are shown regularly under classes, a valuable indication is given as to the necessity or otherwise for adjustment of the train service, or of the scale of fares. Where the average earnings per train mile show a constant downward tendency, one might be obliged to think of cutting down the service.

Similarly with the goods and mineral train services, the earnings per train mile constitute a valuable record for purposes of control.

Passenger miles and ton miles.

The most comprehensive measure of earnings and services rendered is afforded by statistics of passenger unit mileage and traffic ton mileage. Such unit mileages in themselves express the actual amount of the work involved in the transportation of persons and material almost as clearly as a statement of the energy required to lift a certain weight is expressed in the physical sciences by the number of " foot-pounds " that is, the weight of the material multiplied by the number of feet it is to be raised. Theoretically we have in passenger unit and ton mileage statistics, what is perhaps the most satisfactory common measure of railway work which could be devised. While a train or vehicle, and a train mile or a vehicle mile, may and does differ on one administration from the same unit on another administration (or even on the same administration at different dates) the service of moving a passenger or ton of goods one mile affords a basis for a more accurate comparison, whether such comparison is with another administration or not. Such figures are, however (as has been already pointed out) of very limited practical value unless taken in conjunction with other statistics of operation — by themselves they are often positively misleading.

To a considerable and increasing extent, passenger mile and ton mile figures are prepared by British Colonial Railway administrations. Some prepare two sets of ton mile figures, one giving for both passenger and goods traffic the " gross " ton mileage (*i. e.* including the ton mileage of the passenger and goods vehicles themselves as well as of their contents) and the traffic ton mileage. The gross ton mileage is a good index of the physical work performed, and the information affords a satisfactory basis for division of certain classes of expenditure between sections or different services, such, for instance, as the division of certain *general* expenditure between passenger and goods services. Where gross ton mileage is taken out, the weight of passengers, live stock, etc., is in the British Colonies generally arrived at by multiplying the numbers carried by average (estimated) weights of passengers, etc.

Zone statistics

Where, by reason of the cost or otherwise, ton-mile figures cannot be prepared, statements of the numbers of passengers and tonnage of goods, according to the distance carried in zones, say :

From 1 to 10 miles,

From 10 to 25 miles.
— 25 to 50 —
— 50 to 100 —
— 100 to 150 —

and so on, giving the average earnings per ton for each zone, and for different commodities, will be found to be almost as valuable as the average earnings per passenger unit or per ton mile. For purposes of rate making or adjustment, such figures are — in the opinion of the writer — even more valuable, as it is possible from the statements to gauge at once the financial results of a reduction in rates for long or short distance traffic in any of the classes for which the records are kept.

Average haul.

With the figures of passenger unit mileage and ton mileage are usually given particulars of the "average distance haul" for passengers and for goods — information which is not nearly as valuable as the statistics of the traffic under zones to which reference is made in the preceding paragraph.

As a general indication of the rise or fall in earning power of their lines, most British Colonial Railway administrations give the earnings for passengers and freight per mile of line. Such information is more valuable when taken out for the different sections of the line, so as to reflect the development of particular districts. Such figures are occasionally valuable when projects are under consideration for the construction of new lines in districts where the conditions are similar.

Train loads.

Some of the uses of engine, train, and vehicle mileage statistics, have already been referred to, but perhaps the most important direction in which such figures are useful is in securing the efficient loading of the rolling stock, and also in getting the maximum amount of work out of such stock. The latter should perhaps come first, for the expense of providing engines and rolling stock represents a large proportion of railway capital expenditure; how large the proportion is of the whole must ultimately depend on the efficiency with which the engines and rolling stock are utilised. To get the maximum amount of work out of a given quantity of rolling stock means that fixed charges, such as interest on capital expenditure for rolling stock, are kept down to the lowest possible figure.

The great thing is to keep the stock employed to the fullest possible extent in hauling traffic; never to incur light mileage where it can be avoided, and to keep the stock moving and earning money. The minimum of cost cannot be secured unless good engine loads are arranged with trucks loaded as nearly as may be to their full capacity, and passenger cars to the full extent which the accommodation permits.

So far as the use of such statistics more directly bears on the efficiency of the stock used, the principles of application will be dealt with later, but the importance of taking out the average number of passengers and the average number of tons of

freight carried in each train and in each loaded car or truck should be mentioned here. Most British Colonial Railways take out such figures, but the value of the information as an aid to operation would be much greater were the figures given separately for each section, for up and down traffic, and for traffic between specially important points on the system.

Efficiency and utilisation of engines and rolling stock.

As already mentioned, a material factor in economical working is to keep equipment employed on remunerative work. To maintain a check on this, records must be kept of the mileage run by engines and vehicles.

Particulars of the train mileage actually run is kept by all railways; there is, however, no generally accepted classification of such mileage. Most administrations give separately

Passenger train mileage;
Goods train mileage;
Mixed train mileage;

but it is desirable also to supplement this by giving the following particulars, at least, of the train service :

Other revenue train mileage;
Work train mileage;

as well as particulars of other engine mileage, *viz.* :

Assisting (banking, etc.), engines;
Light engines;
Shunting engines.

The latter should be calculated on some uniform basis per hour, preferably six miles, so as to be in accord with the practice in England, North America, and other countries.

The mileage run under each of the above classes, taken out regularly under sections, is of much use if any increases on the figures of previous periods are carefully scrutinised in conjuction with other figures, such as those of the average load per train and the average earnings per train mile. Where these returns are supplemented by statements showing the percentages of each class to the total mileage run, any increase in the proportion of light mileage is at once brought into relief as a matter calling for enquiry. Again, the average mileage run under these heads by the engines in service during the particular period under review as compared with past periods, is a useful indication of whether the greatest possible work is being got out of the stock.

Some (but very few) administrations give also the average gross ton mileage hauled per engine and a comparison with the maximum ton mileage which could have been hauled by each type. Such assumed maximum ton mileage is, of course, a figure

based on ideal conditions, but affords a comparison more or less accurate between possible and actual efficiency.

Nearly all administrations keep for each locomotive a record of the mileage run by it each week or month throughout its running life. The information is of value in arriving at the rate of depreciation of engine stock.

Vehicle mileage and loads.

The average vehicle mileage run by passenger and goods stock is another figure of considerable value as indicating the extent to which the stock is being employed, while the average number of passengers per coach, or the average load per truck in the case of freight, gives information as to the efficiency of the loading, which is of the greatest possible value for comparative purposes. Where loads are substantially and habitually below the carrying capacity of the vehicles the returns will indicate a direction in which enquiry is called for.

Of course any such statistics lose part of their value unless they are taken out separately for sections of the line where the traffic conditions are exceptional; for instance, if one of the sections has very heavy mineral traffic carried in special trucks of large capacity, it is obviously desirable to isolate the figures for that particular section for special consideration.

A few administrations take out figures giving a comparison between the average loads of loaded cars under classes (as well as for all classes as a whole) and place against each class the average possible load. This gives a further general idea of the efficiency of the loading.

As the value of most statistics, and especially those relating to the actual working of traffic, largely depends upon the promptitude with which they can be made available, most railway systems apply quite a number of other checks on working long before some of the more elaborate returns referred to can be completed. In the early part of this paper, reference has been made to the special value of such " temporary " statistics to those entrusted with the operation and management of a railway system. The records of Colonial railways show that considerable attention and importance is attached to daily returns from stations, showing the loading of trains (both passenger and goods) and trucks, and the punctuality and average speed of trains; bad loading and delays in train service are promptly brought to notice and remedied, if possible, before they have time seriously to affect the results of working or give rise to public complaint, as the case may be.

Many uses and combinations (1) of figures referred to above can be and are made by individual administrations, with which it is not possible to deal in a short paper, but a sufficiently clear idea of general methods and principles has been given, and I will now pass to the principles of such statistics as relate more closely to railway working expenditure and the staff employed and material used in operation.

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(1) As instances the following may be mentioned : train miles per engine hour; vehicle miles per train mile; ton miles per vehicle mile.

f) Statistics of Cost of Operation.

In anticipation of that portion of the report which deals with the uniform classification of railway working expenditure, I have already referred to the importance of keeping expenditure records according to services rendered, rather than by departments and of subdividing such heads of expenditure according to proximity of services to the actual conveyance of traffic.

It is only when we come to the consideration of statistics of cost of operation and the principles on which they are based, that the full importance of a good arrangement of expenditure heads is fully demonstrated. Where such a classification exists, the operating officers can be readily supplied at very small cost with information as to the economy and efficiency, or otherwise, of general working. Without a proper classification, results are either obscurred or have to be specially taken out, often at great expense.

With railway working expenditure, as with everything else, the larger the figures are the greater is the difficulty of grasping their significance. Where the only record is the total working expenditure month by month or year by year, comparisons as to the results achieved can only be made if one is satisfied that the conditions during the different periods were practically unchanged. Whether increases or decreases are shown as between one period and another, enquiry as to the causes which gave rise to them is naturally suggested. An increase (even with a decrease in the train mileage run) does not necessarily imply bad working; it may have resulted in a large increase in the net surplus available, and be partially or wholly justified it may be due to the operation of an increased mileage of lines, or to increased facilities being given in the matter of train services, to an increase in the volume of traffic handled, or to some necessary adjustment of rates of pay of the railway staff.

Similarly, a falling off in the expenditure may be due to a reduction in the services rendered or to other causes, and may or may not be a matter for congratulation.

To make the position clear to the responsible officers of an administration it is essential, firstly, that the accounts should be in such a form as will be helpful and, secondly, that the "unit" or other statistics prepared should be appropriate and sufficiently complete to admit of correct deductions being arrived at without much trouble.

Whatever the heads of expenditure are, it is requisite that they should separate expenditure in connection with railway working from expenditure on services of a subsidiary or independent character. For the purpose of setting out the further development of statistics, it will be assumed that they distinguish clearly between expenditure for

1° Maintenance of way and works,
2° Maintenance of equipment (engines and rolling stock),
3° Transportation (*i. e.* running expenses),

4° Traffic,
5° General and other charges,

this being a division easy to follow and one to wich quite a good number of the accounts kept by British Colonial railway administrations could with very few alterations be made to conform.

Unit statistics of cost.

The expenditure under each head, sub-head, and item is in most railways also reduced to " averages per unit," in the same manner as the earnings are worked out according to different units. The units used for expenditure are the same as those used for earnings; that is, the expenditure for each head may be shown :

Per open mile.
Per mile of single track.
Per train mile.
Per vehicle mile.
Per gross ton mile.
Per revenue ton mile.
Per passenger unit mile.

The resulting figures are placed alongside the corresponding figures of earnings for the same units, and afford a general view (when compared with previous periods) of the results of operation.

So far as British Colonial railways are concerned, the most generally used unit for general comparisons is the " train mile ".

Most administrations also show the percentage of each head of expenditure to

a) Earnings,
b) Total Expenditure,

a statement which is of considerable value to the administration in bringing to notice any radical variations in the proportions of the expenses for particular services at different periods.

Statistics of staff employed.

An instructive and useful general statement (compiled by several of the systems which have furnished information) shows for each separate branch of the railway service under specified grades the number of staff employed and their remuneration for the period covered, as well as similar information for previous periods for purposes of comparison. Any increases or decreases are also shown and the average number, average remuneration, and cost for each grade per open mile and per train mile. Where comparisons are instituted with the figures of other administrations (which should be possible in the case of government railways or railways under the same control) such statements bring out the merits or demerits of any particular organisation, for in almost every administration by far the larger portion of the cost of working is represented by personal emoluments.

Sectional figures of expenditure.

Before passing on to statistics applying more particularly to the expenditure and working of individual departments or branches of the railway service, attention is drawn to the value of records showing separately the expenditure of the different branches or sections of a railway as a means of securing efficient and economical working. In quite a number of colonial railways (including the different systems in South Africa) such sectional records or statistics are regularly prepared. A specimen of the forms on which they are prepared on the Central South African Railways is reproduced (1) in order to give an idea of what is meant. Blue prints of the completed forms are sent regularly to all the principal operating and other officials who have it in their power to influence expenditure. They are thus enabled to compare the working of one line with another — the lines for which they are responsible with those of their colleagues — and a spirit of friendly rivalry is induced which has been found is actual practice to result in large savings in expenditure. It will be seen that the expenditure for each section is given in totals and sub-totals as well as

per track mile,
per train mile,
percentage of earnings,
percentage of total expenditure.

The amount regularly set aside for the renewals of capital assets of each section is shown separately in all cases, as the provision made for depreciation is a matter settled by the chief executive authority and is not controlled by the operating officials in any way.

In order to arrive at the working expenses on particular sections of the lines, certain items of expenditure common to several or all sections have of course to be *pro-rated* or distributed; it is not possible to formulate any general rules for such distribution which could be applied to railways generally. The cost of *Maintenance of Way and Works* can, as a rule, be accurately allocated to sections (any engineering superintendence being distributed as a percentage on the whole). That for *Maintenance of Locomotives*, including superintendence, can usually be apportioned between sections on the basis of the engine mileage run on each. Similarly, the cost of *Maintenance of Passenger and Goods Vehicles* can be fairly apportioned according to the vehicle mileage run on each section by passenger or goods vehicles.

Transportation Running Expenses can usually be charged to the actual sections in which the expenditure was incurred, and any balance distributed pro rata to the train mileage run on the different sections. Expenses at large terminal stations sometimes require special treatment and distribution over the sections benefited.

(1) See part 5.

Traffic Expenses (*Stations, etc.*) are to a large extent capable of allocation to actual sections, and what remains can be fairly distributed on the basis of train mileage.

General and other charges can as a rule be charged out to sections as a percentage on other expenditure.

Apart from the use of sectional figures as an aid to operation, they are often found useful when considering the claims of particular districts for increased facilities or additional lines. Notwithstanding the fact that they are based to some extent on averages, the writer believes that with care they can be made to reflect accurately the actual position and effect savings in working, out of all proportion to the cost of their preparation.

Division of expenditure between "passenger" and "goods" services.

It might be expected that, as they have largely followed English methods and practices, few railways in the British Colonies would take out separate figures of the cost of conducting the passenger and goods services and the cost per passenger per mile and per ton mile, but this is not the case. Such figures are regularly taken out by most of the larger administrations and periodically by some of the smaller ones. Unfortunately, there is no uniform basis for arriving at such figures, which must depend for their accuracy on the degree of precision with which expenditure can be assigned to the passenger or goods services.

There can be little doubt that with the exercise of care in their preparation, separate statistics of the cost of hauling passengers and goods afford most valuable information to those directing the operation of a railway. Such figures should, in the opinion of the writer, be regarded as approximate only and as of value for administrative rather than for operating purposes; ton mile costs for instance have and should have great value as one (but *only* as one) of the factors to be taken into consideration in fixing rates; for if they are reasonably accurate they afford a better measure of the value of the services rendered than any other unit. Even as regards operation, they give in one figure more complete information as to the average cost of transportation on particular lines or sections than can be obtained otherwise, and by long continued adherence to the same method of compilation, comparative figures of undoubted value are obtained since they represent in crystallized form practically all the elements of cost. The preparation of such statistics entails considerable expense, and the question whether the advantages obtained are such as to warrant such an expense is one which can be decided only by the administrations concerned.

Ton mile statistics.

The whole question of the desirability of taking out ton mile statistics is of a controversial character, and as it is impossible in this paper to discuss adequately the pros and cons thereof, I propose simply to offer some suggestions as to a method of apportioning expenditure between the passenger and goods services, in order to obtain the benefit of the criticisms of those present and, if possible, lay the foundations of some method which will be capable of general application.

All working expenditure incurred directly in connection with passenger or goods service to be allocated specially as either " passengers " or " goods," as the case may be. So far as expenditure is common to the two heads, the basis of division between " passengers " and " goods " to be as follows :

Permanent Way and Works Maintenance distributed pro rata to train mileage of passenger and goods trains.
Locomotives Maintenance distributed pro rata to passenger train mileage and goods train mileage.
Coaching Stock Maintenance to be allocated to " Passengers ".
Goods Stock Maintenance to be allocated to " Goods ".
Transportation (Running Expenses) to be allocated to passengers and goods in proportion to mileage run by passenger and goods vehicles.
Traffic Expenses to be apportioned on basis of passenger and goods train mileage.
General Charges to be apportioned as a percentage on total other expenditure.

In the case of administrations which are in the habit of taking out the gross ton mileage hauled (*i. e.* the total ton mileage including that of the vehicles containing the traffic) it is possible that the above suggestions may not be the best possible, but as against this it has to be borne in mind that comparatively few administrations do take out figures of gross ton mileage, and what is sought is some general scheme which can be applied to most administrations without imposing on them the necessity of getting out additional statistics.

Attention is now directed to statistics specially relating to the working of individual branches of the railway service.

Maintenance of Way and Works.

Maintenance of way, works, and stations.

Most administrations prepare statements showing under each head, sub-head, and item of expenditure the cost of maintenance " per mile of line maintained " giving comparisons with the figures for previous periods. As a rule, the mileage on which the costs are worked out is " route " or " point to point " mileage, but in many cases the figures are also given " per mile of single track including sidings "; the latter is the more satisfactory. The expenditure under each item is usually also given per train mile and, in the case of administrations which are in the habit of taking out gross ton mileage, per 1,000 gross ton miles. The percentage of each of the different items to the total expenditure for Maintenance of Way and Works is also usually given.

All of these figures are useful; where it is not considered necessary to take out so

much detail, it would seem to be advantageous to give information, at any rate, as to the costs

a) per mile of single track,
b) per total train mile.

Statements showing by districts the cost of maintenance per mile of single track, under heads and sub-heads, and statements showing for each grade of the staff the average number employed (and the cost) per mile of single track for each section will be found, perhaps, as important for purposes of general control and comparison as any statements usually got out in connection with Maintenance of Way and Works.

So far as the permanent way itself is concerned, quite a number of other statistics are got out by different administrations with a view to ensuring that the capital assets of the administrations are maintained in good condition and that economies in working are not effected at the expense of Capital Account; amongst them may be mentioned the following which are regularly taken out by a number of railways amongst those furnishing their information for this paper :

Ballast. — Statistics of the number of cubic feet of different kinds of ballast put into the track, giving the cost per hundred cubic feet (by districts).

Sleepers renewed. — Statistics of the number of sleepers of different kinds taken out of the track and replaced, giving ages of the sleepers renewed (by district).

Rails relaid. — Statistics of the number of rails taken out of the track and replaced, giving weights of rails of different sections and values (by districts).

Rails found broken. — Statistics of broken rails discovered, giving mileage in each case and particulars and cause of break.

Relaying. — Particulars of cost of relaying work carried out in each district, showing separately expenditure for wages and material.

Extraordinary expenditure for Maintenance. — Statements of special work entailed by slips and washaways (by districts).

Bridges. — Statistics of the cost of maintenance of each of the principal bridges in each district.

Stations and Buildings. — Particulars of the cost of maintenance of each of the principal buildings on the system (by districts).

Maintenance of equipment.

Particulars of the statistics commonly prepared as to the maintenance of equipment by railways in the British colonies are given below.

Maintenance of Engines.

Cost is usually worked out per train mile and per engine mile. (In many cases also the average cost of maintenance per 1,000 gross ton miles is given.)

Statistics are also usually kept of the mileage run by each engine, month by month, and the actual cost for repairs of each engine.

Note. — If the cost of repairs is made to include running repairs (which unfortunately is not usually the case) it affords important information as to the relative expensiveness of maintenance of engines of different types.

Figures of the engine mileage run by each engine are sometimes kept and are valuable in arriving at the proper provision to be made out of working expenses for replacement of particular types of engines.

As a check on working expenses and to ensure the maintenance of a proper standard, many British Colonial administrations prepare periodical statistics of the number of engines repaired and overhauled, giving particulars under classes of the repairs effected. The particulars of such repairs vary considerably for different administrations, but the following particulars are usually given :

Total passed through shops;
Built : new;
Re-erected;
Thoroughly overhauled;
Heavy repairs;
Light repairs;
Painted and varnished;
Touched up.

Special statistics of locomotive boilers repaired are usually kept.

Passenger Vehicles : Maintenance.

The expenditure for maintenance of passenger vehicles is usually reduced to statistics giving the average cost per passenger train mile and per 1,000 passenger vehicle miles. As in the case of locomotives, statistics are usually kept of the number of passenger vehicles of each class repaired and overhauled during the year, classifying the repairs under appropriate heads, giving for each the cost and the average cost per vehicle.

Goods Stock : Maintenance.

Similar statistics to those kept in the case of passenger stock are usually prepared for goods vehicles. In order to get at the relative merits of different classes of trucks, much importance is usually attached to keeping separate records for the different types of trucks, especially where there is a great divergence in such types (as in the case of administrations carrying very heavy mineral traffic in specially designed and constructed trucks of large capacity).

Transportation (Running) Expenses.

Transportation: running expenses.

Since running expenses usually constitute a large proportion of railway working expenditure, it is not surprising that voluminous statistics are kept by most administrations in connection with this particular service. The largest element in running expenses is usually the remuneration of the drivers and firemen and other trained staff, and special statistics are, as a rule, prepared to show the cost per train mile for such services, the number of staff engaged, the average mileage run per man — advantage being taken of such returns to compare the results achieved on different sections of the line. In addition to the detailed statistics showing the cost of running per train mile and per engine mile, many administrations secure an additional check by taking out the average cost per 1,000 gross ton miles or per 1,000 vehicle miles for the whole system as well as for districts. As a rule, regular comparisons are also periodically instituted between the numbers of the running staff, their average pay per man, and the average cost for each grade per train mile and per engine mile.

Another effective check on the expenditure for this service which appears to be fairly generally exercised is the compilation of statistics of the working of each engine shed on the system giving the shed costs in great detail, and the average cost per engine mile, worked out on the mileage run by engines from each shed.

Most administrations agree in taking out in detail statistics of the coal consumption per train mile and per engine mile.

Where considerable expenditure is incurred for handling coal or pumping water, it is a common practice for administrations to take out, for each coaling and pumping station, the costs per ton and per 1,000 gallons, respectively. Comparisons between such stations are instituted thereafter for the purpose of bringing to light any excessive cost (where such exists) which may admit of reduction, either by the provision of more economical appliances or by the reduction of labour costs in other ways.

Oil consumption is usually worked out separately for engines and vehicles per engine mile and per 1,000 vehicle miles, respectively. Regular comparisons are also instituted with lubricating costs at other times and on other lines.

Reference has already been made in the early part of this paper to the importance of certain checks exercised with a view to ensuring the proper loading of trains and vehicles, and to the necessity of keeping a check on light engine and vehicle mileage.

A few administrations take out regularly for each type of engine, statistics of the actual work done (expressed in ton miles) and the cost for each of the principal items making up running expenditure so as to afford a more accurate comparison of the relative efficiency of the different types in use. Such statistics are of an expensive nature to prepare and, as they are not generally compiled, it does not seem to be necessary to do more than observe that they have been found of considerable

value by administrations whose operations are of such a magnitude as to warrant the expense of instituting such special enquiries. On smaller railway systems, operating officials are able to arrive at a judgment sufficiently accurate for all practical purposes without statistics of this nature.

Traffic Expenses.

Traffic expenses.

As a rule, traffic expenses are worked out per train mile. In some cases, the expenditure on each item is shown as a percentage of the traffic earnings. As by far the greater portion of traffic expenses consists of the cost of stations and station staff, special statistics and returns are usually got out showing for each station the number of staff, their pay, and other expenses. Alongside these figures are usually placed particulars of the number of passenger bookings and the revenue and tonnage of goods traffic, in and out, so as to afford a ready comparison between station cost and station revenue. For the larger goods terminals, statements are taken out by many administrations in which the costs of handling, etc., are shown worked out on the tonnage of goods handled.

General Charges.

General and other charges

Most administrations prepare statements showing the cost of these services per train mile, per cent on total earnings, and per cent of total expenditure.

Such general charges are, as a rule, more of the nature of fixed charges than other items of railway expenditure and vary less directly with increases or decreases in the traffic handled. It is necessary, therefore, to scrutinise each individual item separately, and there are few statistics which can with advantage be generally employed to effect comparisons between administrations. With regard to accounting work, however (which is usually embraced under the head of General Charges), certain comparisons have in the past been made between expenditure for this service by the different South African railway administrations on the basis of the cost of different sections of the work, expressed as a percentage of the revenue collected or the expenditure for railway service according to the nature of the work. To effect these comparisons, it is necessary to separate the cost of accounting for (*a*) earnings and (*b*) expenditure; such a division can, it is believed, be made with sufficient accuracy to afford a basis for instituting a very useful comparison, especially so far as the cost of accounting for railway expenditure is concerned.

g) Statistics relating to Indirect and Subsidiary Services.

INDIRECT SERVICES.

By indirect services are meant the branches of the railway service which do not fall within the scope of any of those previously enumerated but exist for the benefit

of the administration as a whole. The most important of these are the Stores Department and Workshops.

Stores department

As a rule, the service of maintaining an adequate supply of stores and material required in railway working is delegated to a special department whose duty it is to keep records under suitable heads of quantities and values of material in stock and any receipts and issues. Most of the returns furnished by the British Colonial railway administrations as to the classes and values of such stores are merely classified statements from the Stock Ledgers. Statistics showing the quantities and, values of material handled at different stores depots are, however, prepared by some administrations in which the stores expenses are stated as a percentage on the value of such receipts and issues. This information is an effective check if comparisons are given with earlier periods, and in those cases where expenditure of the Stores Department is charged out to other departments as a percentage on the value of the stores issued, the preparation of regular monthly or quarterly returns showing what the service is actually costing per cent, ensures that the distribution of the expenditure shall respond readily to any change in methods of working and cost.

Workshops.

The Workshops of most railways are under the control of the Locomotive Department (or in cases of railways which have adopted American methods of organisation, the Chief Mechanical Engineer). In some cases, there are separate workshops for the engineering and other departments, but modern practice seems to take rather in the direction of centralising work and having it done in the main wokshops, *viz.*, under the control of the Locomotive Superintendent or the Chief Mechanical Engineer, as the case may be. Whatever practice is adopted, the magnitude of the Workshops expenditure of a railway administration is usually such as to necessitate the preparation of regular returns and statistics with a view either to effecting comparisons with the cost of getting the work done elsewhere, the cost on other railway administrations, or the cost of performing similar work during some previous period. Broadly, the work done in the shops may be devided into two main classes :

1° Work in connection with maintenance of equipment.
2° Manufacturing and other work done for other branches of the railway service or for the public.

Reference has already been made to the statistics usually prepared in regard to the maintenance of locomotives and passenger and goods stock. So far as manufacturing work is concerned, most administrations seem to rely on systems of cost accounting for an indication as to whether the work is being done economically or not. In the one or two cases where methods of cost accounting have been developed to a greater extent than is customary amongst railway administrations regular statistics are taken out of the cost of manufacturing particular articles or spare

parts, thus admitting of comparisons being instituted between the cost of carrying out any particular class of work at different times. Apart from the value of such records as a check on uneconomical working, statistics of this nature are found to be exceedingly useful as a guide in preparing estimates of the cost of carrying out any work and also in connection with the development of any system of remuneration by piece-work. Other statistics that have apparently been found of use in Workshops control are statements of expenditure for each of the different shops, showing under separate items the charges for shop superintendence, chargemen, artizans, labourers, upkeep of machinery, power, light, heating, etc., and the percentage of such different items to the total expenditure of each shop. Where there is a foundry, or where an administration makes or rolls its own steel or carries on any separate industry of a similar nature, the ordinary commercial practice of taking out figures showing the output and the cost per ton or per other unit is usually followed with advantage. This observation may be regarded as applying also to the electric light and power branch of a railway where statistics are almost invariably taken out of the expenditure for generating and distribution per Board of Trade unit.

SUBSIDIARY SERVICES.

Quite a number of railways perform services which are distinct from railway working although they are, as a rule, closely connected therewith. So far as the British Colonial railways are concerned, the most important of such subsidiary services are the cartage of traffic to and from stations, the provision of meals and hotel accommodation to passengers (in many cases to the general public also) and the running of steamship services in connection with the railways. Where such services are conducted, the statistics got out and the checks applied to expenditure are, as a rule, of a slightly different nature to those pertaining to the railwy service proper.

The cost of cartage service is usually taken out under suitable heads for each station and statistics prepared showing cost per ton handled.

Catering and hotel services are usually reduced to such statistics as are kept by those engaged in the business of catering outside the railway service. A useful statement which has been furnished to me gives a comparison for different periods between the earnings, expenditure, net earnings, and percentage of profit at each of the station refreshment rooms, showing separately receipts and expenditure for meals and for alcoholic and other liquors, tobacco, cigars, cigarettes, etc. For dining-cars the earnings, expenditure, and net earnings for each car are shown separately and the average cost of meals served.

As regards statistics of steamship services, these usually follow the same general lines as are adopted by steamship companies.

h) Other Miscellaneous Statistics.

Staff: social condition.

Apart from the statements showing the number and remuneration and average pay of Staff in individual departments already referred to, it is quite usual on Government railways to furnish a considerable amount of information as to the condition of the Staff. The value of such information is certainly great to the political economist, and it is occasionally useful to those directing the operation of a line. The following statements among others are prepared by some of the Colonial railways :

Statistics of social condition of Staff showing nationality, age, whether married or single, average emoluments per day or per month or per annum for each grade, giving comparisons with previous years.

Statistics showing for each grade, the number of Staff employed at the beginning of the period, appointments made during the period, wastage during the period (showing separately resignations, dismissals, services dispensed with, deaths, and transfers), total remaining at the end of the period.

(The figures of wastage worked out as a percentage on the Staff employed will be found of interest and use in connection with Staff arrangements, especially in a large administration where the Staff is sufficiently numerous to allow of the operation of the law of average.)

Where pension and other institutions exist for the benefit of the Staff statistical information is usually compiled setting out the extent to which the privileges are availed of.

Other social statistics.

In practically all British Colonies, railways are required to render returns of accidents arising through the operation of railways. The form in which such returns are prepared varies almost with each Colonial Administration, but the best practice shows separately the number of :

a) Accidents to passengers;
b) Accidents to the general public other than passengers;
c) Railway employees.

For each class, the extent of the injuries sustained is shown, *e. g.* a distinction is made between those killed and those injured. Further, the accidents are classified as far as possible according to their nature and causes.

PART 3.

Uniform Classification of Working Expenses.

Amongst English speaking nations and countries, there have been three successful attempts to introduce a classification of railway working expenses applying to all railways operating within the territory under which such classification has been promulgated. On each occasion, the classification has been one that has either been laid down or enforced by the Government.

The first uniform classification was that applied by Act of Parliament to English railways. This is generally admitted, even in England, to be inadequate and unsuitable, and at the present time, the question of its revision is engaging the attention of a Royal Commission, whose report will probably be available by the time the Congress meets in Berne.

The second was that applied by the Government of India to railways operating in the Indian Empire. This classification (though much more extensive) is in many respects marked by fairly close adherence to the English model.

The third is the comprehensive classification issued in the United States of America by the Inter-State Commerce Commission, and having the force of law. The last of these (as is fitting from the premier position of the United States in the matter of railway mileage) is in point of development far more complete than either the first or the second.

In considering what classification of working expenditure could be adopted for general use, one cannot fail to be influenced by the large amount of work which has been done at the instance of the Inter-State Commerce Commission in America, in settling the classification which now applies to all railways in the United States.

The principal differences between the American classification on the one side, and the English and Indian classifications on the other, are as follows :

1° In America, there is a hard and fast line drawn between
   a) The operating expenses of railways and
   b) Expenditure in connection with subsidiary operations undertaken by railways.

2° In America, the cost of maintenance of locomotives and rolling stock is kept distinct from running expenses.

3° The cost of transportation is in America kept distinct from " traffic expenses." (1)

(1) The term " Traffic expenses " is here used in the sense in which it is applied in America.

4° In America, regular provision is made for charging working expenses with the estimated depreciation of the different classes of capital assets. Expenditure for replacement of such assets is met from depreciation funds, so far as it is covered by contributions standing to the credit of such funds, any balance being charged to working expenses;

5° The American classification not only sets out item by item clearly what shall be charged to working expenses, but also indicates clearly the classes and nature of expenditure which is to be charged to Capital and other Accounts.

Comparison of various classifications.

The differences under the main heads of classification of expenditure in certain different countries are shown below :

Main Heads of Working Expenditure.

United States of America (225,000 miles).	*Great Britain* (24,000 miles).	*British India* (29,000 miles).	*Typical British Colonial Railway.*	*France* (30,000 miles).
Maintenance of Way and Structures.	Maintenance of Way and Works.	Maintenance of Way, Works and Stations.	Maintenance of Way, Works and Stations.	Maintenance of Way and Structures.
Maintenance of Equipment.	Locomotive Power.	Locomotive Power.	Locomotive Power.	Locomotive Power and Carriage and Wagon Expenses.
	Repairs and Renewals of Carriages and Wagons.	Carriage and Wagon Expenses.	Carriage and Wagon Expenses.	
Traffic Expenses.	Traffic Expenses.	Traffic Expenses.	Traffic Expenses.	Traffic Expenses.
Transportation Expenses.				
General Expenses.	General Charges.	General Charges.	General Charges.	General Administration.
	Rates and Taxes.	Steamboat Service.		
	Government Duty.	Special and Miscellaneous Expenditure.		
	Compensation.			
	Legal and Parliamentary Expenses.			
	Miscellaneous.			
	Expenditure not allocated.			

From the above tabulated statement, it will be seen that the main heads in the

American classification are intended to, and do, reflect the cost of the several main services connected with railway working, *viz.* :

American expenditure heads.

1° The maintenance of the track and its appurtenances and of the buildings utilised in connection with its operation;
2° *The Maintenance of the Engines and Rolling Stock used for the conveyance of traffic*;
3° *Expenditure incurred in obtaining traffic and in affording information as to the facilities given by lines for the conveyance of traffic*;
4° *Expenditure directly or indirectly connected with the actual conveyence of traffic : such as cost of operation of trains and stations.*
5° General expenses.

As regards heads 1° and 5°, these correspond to a large extent with heads in the classification adopted by most of the railways outside North America — that is to say Nos. 1° and 5° are at the present time practically uniform main heads of expenditure throughout the railway world.

In place of Nos. 2°, 3° and 4° most railways outside North America record their expenditure under the following main heads :

a) *Locomotive Power.* — Includes maintenance of engines (American head 2) and running expenses of engines (American head 4).
b) *Carriage and Wagon Expenses.* — Includes maintenance of rolling stock (American head 2) and running expenses of rolling stock (American head 4).
c) *Traffic Expenses.* — Includes cost of obtaining traffic (American head 3) and station and other staff (American head 4).

Uniformity of expenditure records could easily be obtained by the adoption of a classification comprising :

1° Heads common to most administrations;
2° Separate heads for all items which are treated differently by (*a*) railways in North America and (*b*) other railways.

Such a classification would embrace the following heads :

1° Maintenance of Way, Works, and Structures;

2° Maintenance of Equipment;

3° Transportation and Traffic Expenses.
  a) Running Expenses and Supplies (Locomotives and Vehicles).
  b) Station and other Traffic Staff.
  c) Cost of obtaining traffic, etc.

4° General Charges.

[In the above list Nos. 3°*a* and 3°*b* together would correspond to the head " Transportation Expenses " in the United States classification, and Nos. 2°*a* and 3°*a* together would correspond with " Locomotive Power " and " Carriage and Wagon Expenses " in the other classification.]

The weak part of such a classification is that it is a compromise, and, like most compromises, it does not entirely satisfy the requirements of those accustomed to work to either of the classifications on which it is based. To the manager of an American line, it would seem a retrograde step were the present American classification altered so as to show separately the cost of departments which do not form part of the usual organisation of an American railway, but which exist in countries which have followed English practice, *i. e.* the locomotive department (which has control of the engine-drivers, firemen, and running shed staff) and the traffic department (which has charge of station staff, guards, etc.).

On the other hand, the railway manager in other countries is accustomed to receive information as to the expenditure of each *department* of the organisation of which he has control and any rearrangement of expenditure heads which decentralises or appears to decentralise the expenditure of a particular department must have much to recommend it before securing his adherence.

So far as lucidity and arrangement go, the main heads of the American Expenditure Classification leave little to be desired, and the writer feels that no argument which he could put forward would detract from the superiority of that classification over any other that he has had the opportunity of examining. Whether the general adoption of the American Classification in its entirety would be practicable at the present time or not is a matter worthy of discussion; if not, such a compromise as that suggested above appears to the writer the only alternative to losing the advantage of being able to institute comparisons with American systems.

Only the main heads (or grand divisions) of working expenditure have been dealt with above. For small railways it is quite conceivable that no more extended classification of working expenditure would be necessary than is comprised by the main heads under discussion, *viz.* :

1° Maintenance of Way, Works, and Structures;
2° Maintenance of Equipment;
3° Transportation and Traffic Expenses;
4° General Charges.

For larger systems, however, effective control would not be possible without some subdivision of such main heads. Such further analysis might with advantage be based on the actual subdivision of the work performed, since this remains practically the same whatever changes in organisation may take place.

In the annexures to this paper (1) an attempt has been made to indicate for each main head of expenditure such sub-heads as appear generally suitable for adoption. In a third column, the process of subdivion is carried still further so as to cover the requirements of railways desirous of obtaining still more detailed information from their expenditure accounts. The classification outlined is composite, based principally on American practice with some slight alterations and additions based on South American (Buenos Ayres Great Southern), French, British, and British Colonial practice.

The proposals cover only the working expenditure of a railway, that is, the total cost of maintaining in good order and condition the capital assets of the raiway and of carrying on the business of transportation, as distinct from the cost of performing other services (described in America as " Outside Operations ") which are often performed by railways but equally often left to other agencies or put to tender.

TREATMENT OF EXPENDITURE ON " INDIRECT " SERVICES.

In connection with the matter of classification of working expenditure it is necessary specially to mention certain general services more or less directly connected with railway working such as the following :

Stores Department;
General Workshops;
Electric Light and Power Branch;
Sanitation.

If the total cost of working a railway is to be recorded under certain main heads, it is submitted that all expenditure in connection with such subsidiary services as those set out above should be taken out separately and distributed on some well considered basis over the main expenditure heads themselves, having regard to the amount of work done for each. Unless there is uniformity in regard to the treatment of such expenditure it is apparent that no effective comparison is possible between one railway and another. Absolute uniformity in the expense classifications of these separate accounts is not essential at the present time, although desirable.

Similarly, it is desirable to keep separate records of such expenditure as that on

Fire and other insurance,
Contributions to pension funds, sick funds, etc.,

and to distribute the charges over the main heads of working expenditure if the total cost under each main head is to be arrived at.

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(1) See part 5.

OTHER MATTERS AFFECTING WORKING EXPENDITURE.

Other matters closely connected with the classification of expenditure arise out of the varying methods of providing for or accounting for

a) Maintenance, etc., of Staff Quarters, House Property, etc.;
b) Depreciation of Capital Assets;
c) Capital Expenditure and expenditure for Betterments.

In order to bring the question of the best method of treatment of such services under consideration, the following information is afforded as to the practice followed by the Central South African Railways — practice based largely on those obtaining on certain large lines in South America:

Reale state.

a) Any profit (or loss) on "Real Estate Account" is carried to net revenue account. All revenue and expenditure in connection with quarters or other structures for which the administration receives or might receive rent is carried to a separate account called "Real Estate." Such structures comprise:

Quarters let to employees and others for which rent is paid by the occupier;
Quarters let to employees and others for which rent is paid by the department;
Buildings occupied by the cartage department;
Buildings occupied by the catering department.

The revenue includes all rents and receipts for water, sanitary and other services. (Where quarters are occupied by employees rent free, the amount of the rent is charged to the departments to which the employees belong.) The Expenditure includes cost of maintenance, water supply, sanitation, rates and taxes, fire insurance, depreciation, etc.

Depreciation of capital assets.

b) Provision is made for charging working expenditure with amounts for depreciation and crediting such amounts to renewals or replacement funds until such time as it becomes necessary to renew the different assets. The following example will serve to explain the working of the different depreciation funds:

A locomotive is purchased at a cost of £5,000 on the opening of the railway, and is placed in traffic on 1. January, 1908. Its life is estimated at 20 years. Each year (in addition to the cost of *all* repairs) one-twentieth of its original cost is charged to working expenses under Locomotive Maintenance (depreciation) and credited to "Locomotive Renewals Fund." By the 31st December, 1927,

this fund will show a credit balance of twenty times £250=£5,000. The original locomotive is now worn out, its scrap value being, say, £300. It is desired to purchase a new locomotive in place of the old one, and the following adjustment is made in the books :

An asset worth £5,000 has disappeared, so Capital Account is credited with £5,000 and Renewals Fund debited with that amount.

On the purchase of a new locomotive, say, for £6,000 Capital Account is debited with the cost.

As regards the scrap value of the old locomotive, it is considered desirable for the present to credit Renewals Fund with the amount realised (less any cost of breaking up or of sale); this amounts in fact to an additional contribution for depreciation.

In case the locomotive were scrapped at the end of 10 years (*i. e.* 10 years before its estimated life expired) working expenditure would still be charged with depreciation on the engine for the remaining 10 years. If, on the other hand, it lasted 50 years (*i. e.* 30 years beyond its assumed life), no depreciation would be charged on it during the last 30 years.

All assets of the railway (and of subsidiary departments) which are liable to depreciation are treated in the same way, the percentage set aside for depreciation being based on the estimated life. All money for replacements is provided by transfers from the different " Renewals Funds."

[It will be apparent that uniformity with regard to the matter of depreciation must be attained before effective comparisons can be made between two or more railway systems. At present, some administrations rely upon replacing out of current working expenditure capital assets which are no longer serviceable, and as a rule, no distinction is made in their accounts between ordinary working expenditure and expenditure for such replacements. In addition to rendering impossible any comparisons with working results of other railways which meet such special expenditure from renewals funds, such a practice seriously disturbs comparisons on the same railway between the working expenditure of a year when little renewal work has been undertaken, and a year when much of it has had to be done. This it is contended is fair neither to the administration nor to the investor who has provided the capital required for railway purposes.]

Capital expenditure and expenditure for betterment

c) Expenditure for the acquisition of entirely new assets is on the Central South African Railways charged to capital account, and also expenditure for improvements or additions tending to increase earnings or reduce working expenses. Separate records are kept of the capital expenditure of

a) The railway proper.

b) Real Estate Department (dwelling-houses, etc.)
c) Workshops' machinery and equipment.
d) Cartage Department. } (These Departments have separate Capital
e) Catering Department. } Accounts of their own.)

(In the case of the last four items all expenditure for improvements or additions is charged to capital account except in cases where the amount is trivial when it is charged to working expenses.)

In the case of the railway proper, expenditure for improvements and additions is charged to :

Working expenses...	If the amount does not exceed £50.
Betterment Fund ...	If the improvement does not mean the acquisition of entirely new assets or increase earnings or reduce working expenses.

[The importance of securing uniformity in regard to the treatment of expenditure on improvements is so inseparably bound up with the question under consideration that this paper would not be complete were attention not drawn to the fact that there is at present considerable diversity of practice amongst British Colonial railways in regard to the matter.]

PART 4.

Conclusions of Reporter.

Principles of Statistics of Railways in operation.

The majority of the statistics usually prepared on British Colonial railways fall under one of two classes :

1° Those statements or returns (including approximate returns) which are available at a sufficiently early date to serve as an effective aid to operating officers and to the supreme executive head of an administration.

2° Those more permanent records which usually require longer time for preparation and are sometimes of less value for the direction of current operative details than for the purpose of bringing under scrutiny the general results attained as well as the tendencies and influences which the figures indicate so as to serve as a guide to the administration in matters of general policy and finance.

The real test of the worth of statistics of either class in their utility. Money spent in the preparation of statistics which have no value for operating purposes or for purposes of guidance in matters of policy, is money wasted.

In the case of the British Colonial railways, the statistical data taken out varies (as is natural) with local conditions and requirements, and the principle of utility seems to be everywhere well recognised.

In the opinion of the Reporter, the statistical data of a more permanent nature would have much greater value if uniformity were secured in the railway methods of accounting and if an agreement were come to by all railways — parties to this Congress — with regard to such matters at the method of calculating open mileage, train mileage, vehicle mileage, ton mileage, and other units used in the preparation of statistics.

The standardising at any rate of the principal statistical returns and the establishment of a recognised standard classification of statistical data, on lines approved by this Conference, which would be suitable for general adoption, would also add considerably to the value of the statistics of individual railways, since it would enable any one administration to compare results with any other to the advantage of all concerned.

Uniform Classification of Railway Working Expenses.

There is no uniformity in the classification of working expenditure of railways in the British Colonies, although there is a classification common to all the railways in British India.

Generally the classification of such expenditure follows the English model, with such additions and modifications as appear necessary to meet local conditions, but the differences in accounting methods and in the heads of the classification are together so pronounced as to render comparisons between one railway and another either misleading or impossible.

The acceptance of some standard classification of railway working expenditure and of an agreement as to the treatment of expenditure for

a) replacements of capital assets,
b) improvements of capital assets,
c) capital purposes,
d) subsidiary services in connection with railways (such as catering),

would be of inestimable advantage not only to railways in British Colonies but to railways throughout the world generally.

PART 5.

Annexures.

Principles of Statistics of Railways in operation.

1° Draft Forms of Capital Account and Balance-Sheet.
2° Draft forms of Revenue, Net Revenue, and Appropriation Accounts.
3° Specimens of Statistical Forms prepared by British Colonial Railways.
4° Replies of different Railways to questions as to the Statistics found most useful for Operating purposes.

Uniform Classification of Railway Expenses.

5° Draft scheme form Uniform Classification of Working Expenses.
6° Replies of different Railways to questions as to the method of providing, in their Accounts, for depreciation of Capital Assets.
7° Replies to questions as to the treatment of expenditure on Improvements (Betterment).

Capital Account. — Receipts and Expenditure to 30th June, 1909.

EXPENDITURE.	Year ended 30th June, 1909.	Prior to 30th June, 1908.	Total to 30th June, 1909.
1° Open lines :			
a) Permanent Way and Works			
b) Signals and Telegraphs			
c) Fixed Plant and Machinery			
d) Buildings :			
1° Stations and other Transportation Buildings			
2° Workshops and Stores			
3° Other Buildings (General Offices, etc.)			
e) Equipment (*i.e.* Rolling Stock) :			
1° Locomotives			
2° Passenger Stock			
3° Goods Stock			
2° Lines under Construction			
Total			
3° Lines worked by other Administrations			
4° Subsidiary Departments :			
a) Real Estate (House Property)			
b) Catering Department			
c) Cartage Department			
d) Collieries			
Etc., etc.			
5° Discount and other General Charges			
Grand total			
Balance at Credit			
£			

RECEIPTS.	Year ended 30th June, 1909.	Prior to 30th June, 1908.	Total to 30th June, 1909.
1° Government or other Loans or similar obligations, *viz.* :			
a) *b*) *c*) } Details to be given.			
2° Contributions from Railway Net Revenue, *viz.* :			
a) *b*) *c*) } Details to be given.			
3° Receipts from other Sources, *viz* :			
a) *b*) *c*) } Details to be given.			
£			

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Annexure No. 1.

Balance sheet as at 30th June, 1909.

LIABILITIES.	£	s.	d.	ASSETS.	£	s.	d.
Capital account. — Balance at credit.				Cash in Hand and in Transit			
Betterment Fund				Investments, *viz.* :			
Replacement or Renewals Fund				*a*)			
Insurance Fund				*b*)			
Superannuation fund				*c*)			
(Other Funds to be detailed.)				Stores in Hand and in Transit			
Due to other Railway Administrations				Due by other Railway Administrations			
Sundry Creditors				Outstanding Traffic Accounts and Station Balances .			
Appropriation Account : (Balance)				Other Outstanding Accounts			
£				£			

Annexure No. 2.

Revenue Account for Period ended 30th June, 1909.

EXPENDITURE.	Abstract.	Month of June, 1909.	1st July 1908 to 31st May, 1909.	Total to 30th June, 1909.	EARNINGS.	Month of June, 1909.	1st July 1908 to 31st May 1909.	Total to 30th June 1909.
To maintenance of Permanent Way, Bridges, Signals, Telegraphs, and Buildings	1				By Passengers			
					By Parcels			
To Maintenance of Rolling Stock, *viz.*:	2				By Goods and Minerals other than Coal			
Locomotives					By Coal			
Coaching Stock					By live Stock			
Goods Stock					By Miscellaneous			
To Transportation and Traffic Expenses, *viz.*:								
a) Running Expenses and Supplies	3							
b) Traffic Expenses	4							
c) Advertising and Canvassing	5							
d) Compensation	6							
To general Charges	7							
Total								
Balance carried to Net Revenue Account								
	£				£			

Net Revenue Account for Period ended 30th June, 1909.

EXPENDITURE.	Month of June, 1909.	1st July 1908 to 31st May, 1909.	Total to 30th June, 1909.	RECEIPTS.	Month of June, 1909.	1st July 1908 to 31st May, 1909.	Total to 30th June, 1909.
To Interest on Loans and on Interest-bearing Capital				By balance from Revenue Account			
				By Net Revenue from Lines worked by other Administrations			
Total.				By Revenue from subsidiary services (Docks, Steamship, Catering, Real Estate, etc.)			
Balance carried to Appropriation Account				By Interest			
£				£			

Appropriation Account [to 30th June, 1909.]

EXPENDITURE.	Month of June, 1909.	1st July 1908 to 31st May, 1909.	Total to 30th June, 1909.	RECEIPTS.	Month of June, 1909.	1st July 1908 to 31st May, 1909.	Total to 30th June, 1909.
To Contribution to Betterment Fund.				By Balance from Appropriation Account for previous year			
To Contribution to Capital Account, *viz.*:							
a) Expenditure on Capital Works				By Net Profit for period ended 30 June, 1909, as per Net Revenue Account.			
b) Redemption of Loans.							
c) Redemption of Loans (Sinking Funds)							
To dividends.							
Total.							
Balance carried down							
£				£			
				By balance.			

Annexure No. 3. (Specimen 1.)

[Victoria Government Railways.]

Statement showing the total cost (exclusive of Rolling Stock), length, highest point, steepest gradient, and average cost per mile of each line; also the cost of Rolling Stock, Workshops, General Offices, etc., at 30th June, 1907.

LINES.	Length of lines opened for Traffic.			Height of Rail-level above Lowwater Mark.		Steepest Gradient.	Cost, exclusive of Rolling Stock, General Offices, Workshops, etc.	
	Double and over.	Single.	Total.	Highest.	Lowest.		Total.	Average per mile.
	Miles.	Miles.	Miles.	Feet.	Feet.	Feet.	£ s. d.	£
Melbourne to Bendigo exclusive of works, Melbourne to Essendon Junction) . .	100·89	...	100·89	1,902	18	1 in 50	4,826,166 7 9	47,836
(Here follow other sections of lines.)								
Total mileage open for traffic at 30th June, 1907	311 26	3,089·81	3,401·07	...	...	...	...	...
Works, Melbourne to Essendon Junction.	...	...	...	...	...	...	1,603,846 17 5	...
Railway Offices, Spencer Street	...	...	...	...	...	...	161,332 16 6	...
Sheds and Workshops, Williamstown. .	...	...	...	...	...	...	154,054 10 9	...
Sheds and Workshops, Newport. . . .	...	...	...	...	...	...	371,294 10 9	...
General Construction Account (Capital Expenditure common to all lines) . .	...	...	...	...	...	...	372,127 10 11	...
Rolling Stock, Broad-gauge	...	...	...	...	...	...	6,049,415 18 6	...
Rolling Stock, Narrow-gauge.	...	...	...	...	...	...	38,280 10 5	...
Rolling stock, Electric Street Railway. .	...	...	...	...	...	...	14,304 8 3	...
Grand total. . .	311·26	3,089·81	3,407·01	...	...	...	41,251,976 6 10	...

(Specimen 2.)

[Central South African Railways.]

Statement showing Engines owned at 31st December, 1908.

DESCRIPTION.	Stock at 31st December 1907.	During 1908.		Stock at 31st December 1908.	Average tractive force.	Average cost.	Date placed in Traffic.	Condition.			
		Additions.	Reductions.					Good.	Fair.	Poor.	Obsolete.
					lbs.	£					
14 ton Z. A. S. M. . .	2	...	...	2	...	1,715	1889	1	1	...	...
(Here follow similar particulars for all classes of Locomotives.)											

*

Annexure No. 3. (Specimen 3.)

[Central South African Railways.]

Statement showing tonnage of Traffic, grouped according to distance, carried over Home Lines, 1908-1907.

Local Traffic.

RATE.	COMMODITY.	1 to 10 miles.		11 to 25 miles.		(Similar information for 26 to 50 miles, 51 to 100 — 101 to 150 — 151 to 200 — 201 to 300 — etc., etc.)
		1908	1907	1908	1907	
First class . .	Wines and Spirits . .					
	Tobacco and Cigars . .					
	Other First Class . . .					
	Total First Class . .					
(Similar information for other classes.)						

[Central South African Railways.] *(Specimen 4.)*

Statement showing the tonnage of principal classes of Traffic forwarded from the Coast Ports to the competitive zone, 1904 to 1908.

Tonnage.

FROM.	1st Class Traffic.					
	1904	1905	1906	1907	1908	
Cape Ports :						(Similar information for other Classes of Traffic.)
Capetown and Table Bay Docks . . .	2,402	3,166	2,123	1,646	**2,019**	
Port Elizabeth and Algoa Bay . . .	12,979	15,767	14,468	13,164	**13,795**	
East London and Buffalo Harbour. . .	3,613	3,853	2,533	2,145	**2,525**	
Total Cape Ports. . .	18,994	22,786	19,124	16,955	**18,339**	
Durban, Point, and Berea Road. . . .	27,931	32,140	23,262	15,384	**14,467**	
Delagoa Bay	5,398	5,964	5,490	4,765	**6,115**	
Total	52,323	60,890	47,876	37,104	**38,921**	

Percentage of Tonnage.

FROM.	1st Class Traffic.					
	1904	1905	1906	1907	1908	
Cape Ports :						(Similar information for other Classes of Traffic.)
Capetown and Table Bay Docks . . .	4·6	5·2	4·4	4·4	**5·2**	
Port Elizabeth and Algoa Bay . . .	24·8	25·9	30·2	35·5	**35·4**	
East London and Buffalo Harbour . .	6·9	6·3	5·3	5·8	**6·5**	
Total Cape Ports. . .	36·3	37·4	39 9	45·7	**47·1**	
Durban, Point, and Berea Road	53·4	52·8	48·6	41·5	**37·2**	
Delagoa Bay	10·3	9·8	11·5	12·8	**15·7**	
Total	100·0	100·0	100·0	100·0	**100·0**	

[Indian Railways.] *Annexure No. 3. (Specimen 5.)*

Analysis of Working, half-year ended 31st December, 1907.

Progressive number.	HEADINGS.		Six months ended 31st December 1907.	Corresponding period Previous Year.
	No. I.			
	Description of Railway Worked.			
1	Gauge of railway	—		
2	Mean mileage worked	Miles.		
3	Number of stations	No.		
4	Total length of the following gradients :			
	a) 1/150 and less	Miles.		
	b) 1/151 to 1/80	—		
	c) 1/81 to 1/100	—		
	d) 1/101 to 1/200	—		
	e) 1/201 to 1/300	—		
5	Steepest gradient worked			
	No. II.			
	Financial results.			
6	Percentage of net earnings (including steamboat traffic) on capital outlay	Per cent.		
7	Percentage of net earnings on paid-up capital	—		
	No. III.			
	Outlay, Earnings, and Expenses.			
	(Exclusive of Steamboat Service.)			
8	Capital outlay per mile open	Rupees.		
9	Total earnings per mile open per week	—		
10	Total working expenses per mile per week	—		
11	Total earnings per train mile	—		
12	Total working expenses per train mile	—		
13	Net earnings per train mile	—		
14	Cost per 1,000 gross ton miles moved (freight and dead weight)	—		
15	Percentage of total working expenses upon total earnings	Per cent.		
16	Percentage of total working expenses upon total earnings, excluding from both sides of the account the charges for carriage of revenue stores	—		
	(Inclusive of Steamboat Service.)			
17	Percentage of total working expenses on total earnings (for details, see Table No. VII)	—		

Annexure No. 3. (*Specimen 5* [continued].)

Analysis of Working, half-year ended 31st December, 1907 (continued).

Progressive Number.	HEADINGS.		Six Months ended 31st December 1907.	Corresponding period Previous Year.
	No. IV.			
	Division of Expenditure between Coaching and Goods Traffic.			
18	Total working expenses for both coaching and goods traffic, excluding steamboat expenses, and after deducting telegraph and sundry receipts and leaving only the balance of payments to other lines for mileage, etc. .	Rupees.		
	Proportions, *dividing expenditure in ratio of gross ton mileage* (*freight and dead load*).			
19	Coaching	—		
20	Goods	—		
	No. V.			
	Coaching Traffic.			
	Gross Receipts and Mileage.			
21	Receipts from coaching traffic.	Rupees.		
22	Coaching train miles run	No.		
23	Average coaching receipts per train mile. . .	Rupees.		
	Units and Unit Mileage.			
	Number of units carried one mile :			
24	1st Class	Unit miles.		
25	2nd Class	—		
26	3rd or Intermediate Class	—		
27	4th or Lowest Class	—		
28	Total passenger unit mileage.	—		
29	Other coaching traffic	Ton miles.		
	Average sum received for carrying a unit one mile :			
30	1st Class	Pies.		
31	2nd Class	—		
32	3rd or Intermediate Class	—		
33	4th or Lowest Class	—		
34	Average for all classes.	—		
35	Other coaching traffic per ton mile. . . .	—		
	Average number of units in a train :			
36	1st Class	No.		
37	2nd Class	—		
38	3rd or Intermediate Class	—		
39	4th or Lowest Class	—		
40	Total passenger units	—		
41	Other coaching traffic	Tons.		
	Vehicles and Vehicle Mileage.			
	Number of coaching vehicles hauled one mile :			
42	1st Class	Vehicle miles.		
43	2nd Class	—		
44	3rd or Intermediate Class	—		
45	4th or Lowest Class	—		
46	Other vehicles.	—		
47	Brake vans.	—		
48	Total	—		

Annexure No. 3. (*Specimen 5* [continued].)

Analysis of Working, half-year ended 31st December, 1907 (continued).

Progressive Number.	HEADINGS.		Six Months ended 31st December 1907.	Corresponding period Previous Year.
	Vehicles and Vehicle Mileage (continued).			
	Average number of vehicles in a coaching train :			
49	1st Class	No.		
50	2nd class	—		
51	3rd or intermediate class	—		
52	4th or lowest class	—		
53	Other vehicles	—		
54	Brake vans	—		
55	Total	—		
	Average earnings per coaching vehicle per mile :			
56	1st Class	Pies.		
57	2nd Class	—		
58	3rd or Intermediate Class	—		
59	4th or Lowest class	—		
60	Other vehicles	—		
	Carrying capacity hauled one mile (excluding brakes) :			
61	1st Class	Seats.		
62	2nd Class	—		
63	3rd or Intermediate Class	—		
64	4th or Lowest class	—		
65	Other vehicles	Tons.		
	Percentage of freigt upon capacity hauled :			
66	1st Class	Per cent.		
67	2nd Class	—		
68	3rd or Intermediate Class	—		
69	4th or Lowest Class	—		
70	Other vehicles	—		
	Working of Train and Ton Mileage.			
	Gross ton mileage of all coaching trains :			
71	Freight	Ton miles.		
72	Dead weight	—		
73	Total	—		
	Average weight of a coaching train :			
74	Freight	—		
75	Dead weight	—		
76	Total	—		
	Cost of Working and Profits.			
77	Average cost of hauling a coaching train one mile	Rupees.		
78	Average cost of hauling a coaching vehicle with its load one mile	Pies.		
	Average cost of hauling a coaching unit one mile :			
79	Per passenger unit	Pies.		
80	Other traffic per ton	—		
81	Average profit on working a coaching train one mile	Rupees.		
	Average profit on working a coaching vehicle one mile :			
82	1st Class	Pies		
83	2nd Class	—		
84	3rd or Intermediate Class	—		
85	4th or Lowest Class	—		
86	Other vehicles	—		
	Average profit on working a coaching unit one mile :			
87	Per passenger unit	Pies.		
88	Other traffic per ton			

NOTE. — The passenger unit mileage is based on the shortest route, and the train and vehicle mileage on the actual route.

Annexure No. 3. (*Spécimen 5* [continued].)

Analysis of Working, half-year ended 31st December, 1907 (continued).

Progressive Number.	HEADINGS.		Six Months ended 31st December 1907.	Corresponding period Previous Year.
	No. VI.			
	Goods Traffic.			
	Gross Receipts and Train Mileage.			
89	Receipts from goods traffic	Rupees.		
90	Goods train miles run	No.		
91	Average goods receipts per train mile	Rupees.		
	Units and Unit Mileage.			
92	Tons of goods carried one mile	Ton miles.		
93	Average sum received for carrying a ton one mile	Pies.		
94	Average number of tons in a train	Tons.		
	Vehicles and Vehicle Mileage.			
	Number of goods vehicles hauled one mile :			
95	Loaded	Vehicle miles.		
96	Empty	—		
97	Brake-vans	—		
98	Total	—		
	Average number of vehicles on a goods train :			
99	Freight vehicles	No.		
100	Brake-vans	—		
101	Total	—		
102	Average earnings per goods vehicle per mile (excluding brakes)	Pies.		
103	Carrying capacity hauled one mile (excluding brakes)	Tons.		
104	Percentage of freight upon capacity hauled	Per cent.		
105	Average load of a goods vehicle (including both loaded and empty)	Tons.		
106	Average load of a loaded goods vehicle	—		
	Weight of Train and Ton Mileage.			
	Gross ton mileage of all goods trains :			
107	Freight	Tons.		
108	Dead weight	—		
109	Total	—		
	Average weight of goods trains :			
110	Freight	Tons.		
111	Dead weight	—		
112	Total	—		
	Cost of Working and Profit.			
113	Average cost of hauling a goods train one mile	Rupees.		
114	Average cost of hauling a goods vehicle with its load one mile	Pies.		
115	Average cost of hauling a goods unit (*viz.*, one ton) one mile	—		
115A	Average cost of hauling a goods unit one mile, including interest on capital expenditure on open line at the rate of 5 per cent per annum	—		
116	Average profit on working a goods train one mile	Rupees.		
117	Average profit on working a goods vehicle with its load one mile	Pies.		
118	Average profit on working goods unit (*viz.*, one ton) on mile	—		

NOTE. — The ton mileage is based on the shortest route, and the train and vehicle mileage on the actual route.

Summary of the results of maintenance on each system of lines in comparison with those of the last three years.

NAME OF SYSTEM, AND GAUGE.	Year.	Miles of Single Line.	Miles Sidings.	Ordinary and Current Repairs.		Extraordinary Repairs and Renewals.		Average Number of Men Employed per Mile, including Sidings.					
				Cost per Mile of Single Line, Sidings included.	Cost per Mile of Single Line, Sidings not included.	Cost per Mile of Single Line, Sidings included.	Cost per Mile of Single Line, Sidings not included.	Superintendence.	Artisans.	Gangers.	Packers.	Labourers.	Total.
5 ft. 3 in.		M. C.	M. C.	£ s. d.	£ s. d.	£ s. d.	£ s. d.						
	1905	247 74	70 78	106 16 2	113 3 1	14 8 10	18 11 6	0·03	0·13	0·10	0·31	0·17	0·74
	1906	247 74	70 78	113 3 1	145 10 11	35 6 2	45 8 4	0·03	0·11	0·11	0·31	0·22	0 78
Port and North	1907	247 74	70 78	108 10 4	139 9 6	224 16 3	289 3 5	0·03	0·32	0·10	0·31	0·99	1·75
	1908	**247 74**	**70 78**	**127 6 4**	**163 15 3**	**248 15 11**	**320 0 5**	**0·03**	**0 37**	**0·11**	**0·30**	**1·09**	**1·90**
(Similar information for each section.)													

[Western Australian Government Railways.]

Cost of Working the Principal Classes of Locomotives for 1905, 1906, 1907, and 1908.

Class.	Where built.	Date placed on traffic.	Average engine mileage per engine per four weeks.				Tons capable of hauling over [1]ruling grades.	Average cost per engine mile.				Average cost per engine mile per 100 tons hauling power				Where running.
			1908	1907	1906	1905		1908	1907	1906	1905	1908	1907	1906	1905	
							Tons.	Pence.	Pence.	Pence.	Pence.	Pence.	Pence.	Pence.	Pence.	
C	America . . .	1902	1,187	1,952	1,683	1,793	184	16·23	10·70	13·81	11·47	8·82	5·81	7·50	6·23	...
T	Great Britain . .	1889	2,326	1,756	2,123	1,937	108	7·25	10·71	7·81	9·33	6·71	9·91	7·23	8·63	...

[1] Ruling grades on Main Lines :

Eastern	1 in 45	Eastern Goldfields.	1 in 60
Great Southern.	1 in 55	South-Western	1 in 75
Collie	1 in 40	Donnybrook-Bridgetown.	1 in 40
Northern.	1 in 50		

Locomotive Returns for the Year ended 31st March, 1908.

Section on which employed.	Type.	Number of Engines.	Average Speed: Miles per Hour.	Engine Mileage. Detail. Train.	Shunting and Empty.	Work Train.	Total.	Quantity of Stores. Running. Coal.	Oil.	Tallow.	Waste.	Cost. Repairs Wages and Material.	Running. Stores.	Fuel.	Wages.	Total.	Cost per Engine Mile in Pence. Repairs Wages and Material.	Running. Stores.	Fuel.	Wages.	Total.	Days in Steam.
								Cwt.	Qt.	lb.	lb.	£	£	£	£	£						
KAWAKAWA SECTION.	C	1	15	3,720	1,279	422	5,421	933	158	12	75	18	7	71	162	258	0·80	0·31	3·14	7·17	11·42	104
	D	1	15	3,264	1,170	116	4,550	873	138	6	72	32	6	67	138	243	1·69	0·32	3·53	7·28	12·82	94
	Totals	2	...	6,984	2,449	538	9,971	1,806	296	18	147	50	13	138	300	501	1·20	0·31	3·32	7·22	12·05	198
	General charges .			...	...	...	...	...	...	...	...	...	...	...	...	54	...	...	...	...	1·30	...
	Totals. . .			...	...	...	...	...	...	...	...	...	...	...	...	555	...	...	...	...	13·35	...

Similar data for each Section.

[New South Wales Government Railways.]

Comparative Statement showing for Week ending ..... 1907, number of men employed and cost per Engine Mile for Driving, Firing, and Cleaning in each District.

[D., F., C. represent Drivers, Firemen, and Cleaners respectively.
S. H. (shed hands) embraces Engine Turners, Tube Cleaners, Washers-out, Firelighters, and Gland Packers.]

1907.												1906.	Increase or Decrease in 1907.			
District.		Number of Men.			Average Rate per Classified Man per Day.	Amount of wages and expenses.				Engine Mileage.	Cost per Mile Driving, Firing, and Cleaning.	Total Cost per Mile for all Services.		Increase.	Decrease.	Miles run per Man.	
		Classified.	Acting.	Total.		Actual Service Driving, Firing, and Cleaning.	Holidays and Sick Pay.	Other Services.	Grand total.					Cost for all Services.		1907.	1906.
						£ s. d.	£ s. d.	£ s. d.	£ s. d.				[Similar figures for corresponding week in previous year.]				
Eveleigh.	D.	222	39	261	13/6·27	2,161 5 3	92 14 0	9 4 11	2,263 4 2	...	2·725	2·737		0·021	...	...	...
	F.	225	77	263	9/3·89	1,527 0 2	62 10 6	...	1,589 10 8	...	1·922	1·922		...	0·025	...	...
	C.	158	38	119	6/7·68	451 10 9	11 3 0	35 1 11	497 15 8	...	0·559	0·601		...	0·194	...	...
	S. H.	...	...	...	...	...	...	...	178 18 2	...	...	0·216		0·009	...	...	...
		605	38	643	...	4,139 16 2	166 7 6	44 6 10	4,529 8 8	198,543	5·206	5·476		...	0·189	309	275

(Similar information for each District.)

Annexure No. 3 (Specimen 9.)

XIV
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Sectional Statistics. — Showing Expenses per unit under each head of Estimates.

Month of 190 .

SECTION.	Capital Cost (Approximate).	Open Track Mileage.	Train Mileage.	Earnings per Train Mile.	Ordinary Working Expenditure, *i. e.* exclusive of renewals.							
					a) Per Train Mile.						*b*) Per cent of total expenditure. *c*) Per cent of earnings. *d*) Per track mile.	Under same heads.
					Transportation.		Maintenance of Equipment.	Maintenance of Way, Works, and Telegraphs.	Other Expenditure. (General Charges and Misc.)	Total.		
					Traffic.	Locomotive Running.						

(*Continued.*)

Total Expenditure.							Total Earnings.	This year.		Last year.	
Working.					Renewals.	Total.					
Transportation.		Maintenance of Equipment.	Maintenance of Way, Works, and Telegraphs.	Other Expenditure. (General Charges and Misc.)		Amount.	Per cent of Earnings.		Profit.	Loss.	Profit.	Loss.
Traffic.	Locomotive Running.											

Note. — The same information is also shown month by month on a separate statement for each section.

Replies of Different Railways to questions as to which Statistics are considered most valuable for : 1° Watching earnings ; 2° Watching expenditure.

RAILWAY.	1° Earnings.	2° Expenditure.			
		Maintenance of Way and Works.	Maintenance of Equipment.	Running Expenses, Locomotive Department.	Traffic Expenses.
Eastern Bengal State Railways.	The weekly approximate return of traffic and the monthly fluctuation-statement of principal commodities.	...	...	...	...
East Indian Railway.	In watching earnings and development of traffic, most value is attached to the statistics of station to station traffic in different commodities maintained by the Audit Office.	The most effective check is made by comparing the number of gangmen employed on maintenance of road on each district, the cost per mile under each main head of account, and cost per train miles. *Vide* 4, 5 and 6 of the half-yearly report referred to above. A copy of chief engineer's half-yearly report is sent to each engineer.	Engine hours and vehicle mileage, also efficiency. There is no doubt that the most effective check would be to record the expenditure on each engine or vehicle separately, but it is questionable whether the advantages to be derived therefrom would be compensated for by the detailed accounting this would necessitate and the attendant expenses thereof.	Fixed allowances.	...
Assam-Bengal Railway.	Statistics showing goods booked for foreign lines via our junctions, and framing rates accordingly in connection with competitive routes. Little or no passenger competition; tendency to allow passengers to select own route with-	...	...	...	Statement of excess over estimate of expenditure.

Railways.	tional results of working. 2° Statements showing the tonnage of traffic carried. a) according to commodities. b) according to distance carried. Zone statements.	2° Sectional returns of staff employed. 3° Comparisons with other South African Railways.	2° Unit statistics of cost (per engine mile, per vehicle mile, and per engine and vehicle).	according to schedule time) statistics of train loads, statistics of vehicle milage, loaded and empty, "Up" and "Down". Returns of train and engine mileage under classes; returns of costes at different running sheds, coaling, and pumping stations, and comparison with cost on other South African Railways.	dual stations, statistics of earnings and expenditure under sections monthly.
Natal Government Railways.	The weekly statement of traffic indicates the fluctuations that take place and the detailed monthly analysis of commodities is utilised for the purpose of watching revenue received from each class of traffic.	...	The cost of train and engine mileage.	Ton miles.	Statement of staff, increases in pay and numbers. Classification fo appointments. Monthly figures of results.
Cyprus Government Railway.	The classified statements of passenger traffic in money and numbers presented to me monthly and the weekly traffic report, supplemented by verbal advices from traffic inspector, and personal observation.	...	Comparison with corresponding periods and challenging of increases or decreases.	Comparison with corresponding periods and challenging of increases or decreases.	The monthly comparisons of expenditure are the effective checks.
Ceylon Government Railway.	The greatest importance is attached to the goods and coaching comparative return in watching the increase of traffic; these statements are received monthly and show the increases and decreases as compared with the corresponding month in the previous year.	Monthly expenditure is watched and an annual check is kept on expenditure under the various heads per mile of railway open, per train mile, and per 1,000 gros ton miles, and the informations is published in the Administration Report of the Ceylon Government Railway.	The system adopted by us of checking the expenditure on account of locomotives is by engine mileage and carriage and wagon expenditure by vehicle mileage.	...	Taking the expenditure generally, I consider the cost per 1,000 gross ton miles, the freight loads per goods vehicle, and cost of hauling per goods vehicle mile, the number of passengers per passenger carriage, and the cost of hauling per coaching vehicle mile are the best checks on the economical working of the traffic.

Replies of Different Railways to question as to which Statistics are considered most valuable for : 1° Watching earnings; 2° Watching expenditure *(continued)*.

RAILWAY.	1° Earnings.	2° Expenditure.			
		Maintenance of Way and Works.	Maintenance of Equipment.	Running Expenses, Locomotive Department.	Traffic Expenses.
Federated Malay States Railways.	To all statistics.	...	I consider that the check afforded by the total expenditure against each class of stock, divided by the number of such stock passed through the shop and worked out and compared year by year per train mile is an effective check where a large clerical staff is not available.	A statement for the year is prepared, showing cost of department per engine and train mile, against "fuel", "running stores", and wages and material. I consider that these checks are sufficiently effective.	...
Cape Government Railways.	Monthly results of working classified and placed in comparative order, so that rise and fall in any particular items of revenue or expenditure may be seen. These, in conjunction with special returns showing the traffic passing the main junction and depot stations, and the prompt rendering of statements showing the approximate tonnage daily and monthly from the ports to specified sections of line show what is being done on the railways.	Open mile basis is adopted and officers responsible are furnished with details each month.	The costs are compiled monthly by the locomotive superintendent, of the respective systems and checked by the chief locomotive superintendent, who directs attention to any special increase in the rates.	District costs are worked out in the office of the locomotive superintendent, who supplies copies to the district officers and directs attention to any special rate of expenditure.	...
New South Wales Government Railway.	The principal revenue is derived from goods traffic, and all statistics, relating thereto are regarded as the most important. Weekly and monthly statements of the revenue earnings under the four headings are prepared, and constant attention and consideration is given as to how the earnings from each branch may best be increased.	A comparative check of the expenditure incurred under the various schedules in each section, and closely following up all excesses.	Personal supervision and close inquiry into all comparative increases exhibited on the returns produced.	Monthly comparative statements showing each class of expenditure investigated by the head of the branch and criticised and held in check by the administrative committees.	A monthly abstract of the expenditure is prepared under the various schedules.

Annexure No. 5.

Draft Scheme for Uniform Classification of Working Expenses.

Main heads (for Small Railway Systems).	Heads for Larger Railways.	Heads for Largest Systems.
I.— Maintenance of Way, Works, and Structures.	I.— Maintenance of Way, Works, and Structures.	I. — Maintenance of Way, Works, and Structures.
1. Superintendence.	1. Superintendence.	1. Superintendance. *a*) Engineers and other professional staff : salaries and wages. *b*) Office staff : salaries and wages. *c*) Other staff : salaries and wages. *d*) Office and miscellaneous expenditure.
2. Permanent Way : Maintenance.	2. Permanent Way : Maintenance. *a*) Salaries and wages. *b*) Materials and other expenses.	2. Permanent Way : Maintenance. *a*) Salaries and wages. *b*) Materials : 1) Ballast. 2 Sleepers. 3) Rails. 4) Other track materials. *c*) Other expenses.
3. Track Structures : Maintenance.	3. Track Structures : Maintenance. *a*) Salaries and wages. *b*) Materials and other expenses.	3) Track Structures : Maintenance. *a*) Tunnels. *b*) Bridges. *c*) Crossings, fences, cattle guards, and signs. *d*) Signals and interlocking plant. *e*) Telegraphs and telephones. *f*) Electric power and transmission. *g*) Water supply. (Further sub-divisions may be effected under "Wages" and "Material" if necessary.)
4. Buildings and Grounds : Maintenance.	4. Buildings and Grounds : Maintenance. *a*) Salaries and wages. *b*) Materials and other expenses.	4. Buildings and Grounds : Maintenance. *a*) Stations and station grounds. *b*) Other buildings (excluding dwelling-houses, workshops, and stores buildings).
5. Miscellaneous Expenses.	5. Miscellaneous Expenses.	5 Miscellaneous Expenses. *a*) Insurance. *b*) Injuries to persons. *c*) Stores expenses. *d*) Other expenses.
6. Depreciation Fund Contributions.	6. Depreciation Fund Contributions. *a*) Permanent way. *b*) Track structures. *c*) Buildings.	6. Depreciation Fund Contributions. *a*) Permanent way : 1) Rails. 2) Sleepers. 3) Other material. *b*) Track structures : 1) Bridges. 2) Signals. 3) Telegraphs and telephones. *c*) Buildings : 1) Stations. 2) Other buildings (excluding dwelling-houses, workshops, and stores buildings).

Annexure No. 5 (continued).

Draft Scheme for Uniform Classification of Working Expenses (continued).

Main heads (for Small Railway Systems).	Heads for Larger Railways.	Heads for Largest Systems.
II. — Maintenance of Equipment.	II. — Maintenance of Equipment.	II. — Maintenance of Equipment.
a) Maintenance	*a*) Locomotives : 1) Maintenance. 2) Depreciation.	*a*) Locomotives : maintenance : 1) Wages. 2) Material. 3) Indirect expenses, *viz.* : Superintendence. Wages. Material. Use of machinery and power. Other expenses. 4) Depreciation fund contributions.
b) Depreciation.	*b*) Passenger stock : 1) Maintenance. 2) Depreciation.	*b*) Passenger stock : maintenance : 1) Wages. 2) Material. 3) Indirect expenses, *viz.* : Superintendance. Wages. Material. Use of machinery and power. Other expenses. 4) Depreciation fund contributions.
	c) Goods : 1) Maintenance. 2) Depreciation.	*c*) Goods stock : maintenance ; 1) Wages. 2) Material. 3) Indirect expenses, *viz.* : Superintendence. Wages. Material. Use of machinery and power. Other expenses. 4) Depreciation fund contributions.
III. — Transportation and Trafic Expenses.	III. — Transportation and Trafic Expenses.	III. — Transportation and Trafic Expenses.
	a) Running Expenses and Supplies.	*a*) Running Expenses and Supplies : 1) Superintendence. 2) Drivers (wages). 3) Firemen (wages). 4) Guards and conductors (wages). 5) Running shed staff (wages). 6) Other staff. 7) Fuel : Labour. Coal and wood. Plant : maintenance. Other expenses. 8) Water : Labour. Water purchased. Plant : maintenance. Other expenses. 9) Lubricants. 10) Running stores and supplies.

Annexure No. 5 (continued).

Draft Scheme for Uniform Classification of Working Expenses (continued).

Main heads (for Small Railway Systems).	Heads for Larger Railways.	Heads for Largest Systems.
	III. — Transportation and Trafic Expenses (*continued*).	III. — Tansportation and trafic Expenses (*continued*).
	a) Running expenses and supplies (*continued*).	*a*) Running Expenses and Supplies (*continued*) : 11) Coaches : Lighting. Cleaning. 12) Wagons : Cleaning and disinfecting. Tarpaulins : maintenance. 13) Other expenses.
	b) Station and other Traffic Expenses.	*b*) Traffic Expenses (Stations, etc.) : 1) Superintendence. 2) Station masters and clerks (salaries and wages). 3) Porters (wages). 4) Signalmen and gatekeepers (wages). 5) Checkers' wages. 6) Shunters' wages. 7) Other staff (wages). 8) Uniforms. 9) Travelling expenses. 10) Stationery and printing. 11) Lighting and heating. 12) Water. 13) Stores and equipment. 14) Other expenses.
	c) Advertising and Canvassing.	*c*) Advertising and Canvassing : 1) Salaries and wages. 2) Commissions. 3) Advertising. 4) Other expenses.
	d) Compensation.	*d*) Compensation : 1) Personal. 2) Goods and live stock. 3) Damage to property.
IV. — General Charges.	IV. — General Charges.	IV. — General Charges.
	a) General management.	*a*) General management : 1) Salaries and wages 2) Office and travelling expenses.
	b) Accounting.	*b*) Accounting : 1) Salaries and wages. 2) Office and travelling expenses.
	c) Revision of rates and tariffs.	*c*) Revision of rates and tariffs : 1) Salaries and wages. 2) Office and travelling expenses.
	d) Legal expenses.	*d*) Legal expenses.
	e) Other expenses.	*e*) Other expenses.

*

Annexure No. 5 (continued).

Classification of Indirect (suspense) Expenditure.

In the above classification of working expenditure, it has been assumed that separate records are kept of expenditure on such services as the following, and charged out on some well considered basis to the different departments or accounts which have benefited by such indirect expenditure :

Stores expenses ;
Electric light and power ;
Workshops expenses ;
Labour recruiting charges ;
Sick fund and superannuation fund contributions ;
Insurance premiums and expenses.

Although uniformity in the expense classifications of these separate accounts is not essential at the present time, some particulars are given below (based on the practice of the Central South African railways) both as to the heads of expenditure and the basis of distribution, as the adoption of different methods by different administrations affects to some extent the cost of the other services shown in the preceding classification of working expenditure proper.

Stores Expenses.

Heads of Expenditure.	Basis of Distribution.
Superintendence : Salaries and wages Office and travelling expenses *Other expenditure :* Salaries and wages Offices Travelling allowances Sanitary charges Maintenance of stores buildings Miscellaneous expenditure	A percentage is added to the value of stores issued to cover the stores department expenditure.

Electric Light and Power.

Heads of Expenditure.	Basis of Distribution.
Superintendence : Salaries and wages Office and travelling expenses Wages, other than superintendence Materials Maintenance of buildings Miscellaneous expenses Purchase of power and light Depreciation of plant	Charged out to all departments using electric power and light according to consumption. (Cost of train and station lighting charged to traffic department.)

Annexure No. 5 (continued).

Classification of Indirect (suspense) Expenditure (continued).

Workshops Expenses. — Locomotive Department.

Heads of Expenditure.	Basis of Distribution.
Direct expenses . . { Wages. Material	The expenditure of the locomotive workshops is of two classes: 1. Wages of men actually employed on specific jobs and material used for such jobs (direct expenditure). 2. General expenses which cannot be assigned to particular jobs, such as general superintendence, consumable stores, workshops' stores expenses, power, light, etc. (indirect expenditure). These two classes are dealt with in the following manner: *Direct expenditure* is charged out to the actual work. *Indirect expenditure:* A separate record is kept for each shop of all indirect expenditure, except item *d*), and it is charged out by a percentage addition to the labour charges of any work passing through that particular shop. *Item d*): Use of machinery represents the expenditure for maintaining the machinery and for motive power for driving it, also charges for depreciation.
Indirect expenses . { *Workshops expenses:* *a*) Superintendence . . . *b*) Wages . . . *c*) Material . . . *d*) Use of machinery . . . *e*) Other expenses . . .	

Coloured Labour (recruiting and other charges).

Heads of Expenditure.	Basis of Distribution.
Superintendence: Salaries and wages Office and travelling expenses	
Recruiting expenses: Recruiting fees Clothing, etc., for recruits (value recovered from wages) Railway fares	*Recruiting expenses* charged out to all departments in proportion to number of natives supplied.
Compound expenses Salaries and wages. Provisions Medical attendance Heating, lighting and maintenance of buildings, etc.	*Compound expenses* charged to departments in proportion to number of natives maintained in compounds.
Miscellaneous expenses	*Superintendence and miscellaneous expenses* charged out to departments as a percentage on recruiting and compound expenses.

Annexure No. 5 (continued).

Classification of Indirect (suspense) Expenditure (continued).

Sick and Superannuation Funds (contributions to).

Heads of Expenditure.	Basis of Distribution.
1. Contributions by administration to sick fund	1, 2 and 3. Charged out to departments in which employees are serving. 4. Charged to coloured labour account (see above).
2. Contributions by administration to pension fund	
3. Contributions by administration to sick fund to cover medical examination of applicants for employment . .	
4. Contributions by administration to sick fund for medical attendance on coloured labourers.	

Insurance.

Heads of Expenditure.	Basis of Distribution.
1. *Fire insurance:* Premiums paid to companies . . . . . . — — to administration's fire fund . . . . Fire brigade pay and expenses.	1. Charged out to departments for which insurance is effected, but insurance of all buildings occupied by traffic department or in connection with running of trains is borne by maintenance department; insurance of cartage, catering quarters, and other *buildings* for which rent is charged is a debit to real estate account. Insurance of loco. workshops is a charge to workshops account, and of stores buildings to stores expenses. Insurance of contents in all cases is debited to the department in whose charge such contents are.
2. *Marine insurance:* Premiums paid to companies . . . . . . — — to administration's fund	2. Charged to stores department and added to cost price of stores.
3. *Workmen's compensation insurance:* Premiums paid to administration's fund.	3. Charged to departments employing the workmen as a percentage on the wages paid.

Annexure No. 6.

Depreciation of Capital Assets. — Replies of various Railway Administrations as to the method of providing for Depreciation and Renewals of Capital Assets.

ADMINISTRATION.	Question. Is any provision made in working expenses for depreciation of permanent way, rolling stock, and other assets to provide a fund for replacement on expiration of life? If not, how is such expenditure met as that on the relaying of a whole section or renewing a bridge with the same weight of material, or replacing locomotives, coaches, wagons, or machinery when life is exhausted?	Question. If no provision for depreciation is made at present, are you in favour of charging each year with something on account of that wear and tear which cannot be made good by ordinary maintenance, and do you consider in fixing such depreciation charges, obsolescence should be taken into account? If each year's working is not charged with some contribution for depreciation, and expenditure for replacements is charged to working expenses, do you find that it has a disturbing effect on expenditure and renders comparisons with other years of less value? Also what security have you that economies are not effected at the expense of capital assets?	Question. If provision is made for depreciation, please say how it is calculated. If on the estimated life of the assets, please give the yearly percentage of the cost which is set aside for each class of asset, and say whether labour charges are included in the cost on which depreciation is calculated. Also say how the value of any scrap is treated on replacement. Full information as to the working of the depreciation fund will be particularly valuable.
	Replies.	**Replies.**	**Replies.**
East India Railway .	No. Charged to revenue working expenses.	This is not permissible under Government orders. Our earnings and expenditure are so large that we have found no undue disturbance in our net revenue.	Not made.
Eastern Bengal State Railway.	No. All renewals form a charge to revenue, as capital cannot be charged twice over. Renewals involving improvements are debited partly to capital, the charge to capital representing the value of the improvement.	...	Value of old material is credited to revenue on the renewal estimate.
South Indian Railway.	No. Cost of renewals are generally debited to revenue working expenses.	No. The system of working on this railway does not require the proposal suggested here, as we work on a fixed programme of renewals. Comparison is made, excluding such extraordinary renewals. Budget grant for the year and provision in the sanctioned estimates are the securities.	Value of scrap is credited to the work concerned by debit to stores at the present value. There is no depreciation fund, nor is it necessary.
Assam Bengal Railway.	No.	...	

Annexure No. 6 (continued).

Depreciation of Capital Assets. — Replies of various Railway Administrations as to the method of providing for Depreciation and Renewals of Capital Assets.

ADMINISTRATION.	Question. Is any provision made in working expenses for depreciation of permanent way, rolling stock, and other assets to provide a fund for replacement on expiration of life? If not, how is such expenditure met as that on the relaying of a whole section or renewing a bridge with the same weight of material, or replacing locomotives, coaches, wagons, or machinery when life is exhausted?	Question. If no provision for depreciation is made at present, are you in favour of charging each year with something on account of that wear and tear which cannot be made good by ordinary maintenance, and do you consider in fixing such depreciation charges, obsolescence should be taken into account? If each year's working is not charged with some contribution for depreciation, and expenditure for replacements is charged to working expenses, do you find that it has a disturbing effect on expenditure and renders comparisons with other years of less value? Also what security have you that economies are not effected at the expense of capital assets?	Question. If provision is made for depreciation, please say how i is calculated. If on the estimated life of the assets, pleas give the yearly percentage o the cost which is set aside fo each class of asset, and say whether labour charges ar included in the cost on which depreciation is calculated. Also say how the value of any scrap is treated on replacement. Full information as to the working of the depreciation fund will be particularly valuable.
	Replies.	**Replies.**	**Replies.**
Ceylon Government Railway.	No provision is made against depreciation; expenditure for relaying permanent way and renewing bridges with same weight of material or replacing engines on stock is met from revenue.	I am not in favour of a depreciation account, but would favour annual contributions of fixed sums to a "relaying provision account," "bridges provision account," etc., where the actual yearly expenditure on account maintenance cannot be equally distributed for reasons that are obvious. The charging of expenditure for heavy replacements to working expenses has a disturbing effect on expenditure, but does not render comparisons with other years of less value, as such expenditure is taken into consideration when making comparisons.	Proceeds of sale of scrap are credited to revenue.
Cape Government Railways.	All replacements are performed at cost of revenue.	(*a*) No; except in case of rolling stock. (*b*) No; after a system of railways has been working for a number of years, a normal condition is reached, when the renewals can be regulated on a fairly constant basis, except in the case of rolling stock, in respect of which a depreciation fund should be established. No work is allowed to be undertaken to debit of capital without the express written sanction of the general manager to the department concerned and the chief accountant.	Scrap, except rolling stock, is credited to the working department concerned, and rolling stock is credited to rolling stock account replacement.

Annexure No. 6 (continued).

Depreciation of Capital Assets. — Replies of various Railway Administrations as to the method of providing for Depreciation and Renewals of Capital Assets.

ADMINISTRATION.	Question. Is any provision made in working expenses for depreciation of permanent way, rolling stock, and other assets to provide a fund for replacement on expiration of life? If not, how is such expenditure met as that on the relaying of a whole section or renewing a bridge with the same weight of material, or replacing locomotives, coaches, wagons, or machinery when life is exhausted?	Question. If no provision for depreciation is made at present, are you in favour of charging each year with something on account of that wear and tear which cannot be made good by ordinary maintenance, and do you consider in fixing such depreciation charges, obsolescence should be taken into account? If each year's working is not charged with some contribution for depreciation, and expenditure for replacements is charged to working expenses, do you find that it has a disturbing effect on expenditure and renders comparisons with other years of less value? Also what security have you that economies are not effected at the expense of capital assets?	Question. If provision is made for depreciation, please say how it is calculated. If on the estimated life of the assets, please give the yearly percentage of the cost which is set aside for each class of asset, and say whether labour charges are included in the cost on which depreciation is calculated. Also say how the value of any scrap is treated on replacement. Full information as to the working of the depreciation fund will be particularly valuable.
	Replies.	**Replies.**	**Replies.**
Central South African Railway.	Yes.	...	On the estimated life of the asset concerned : Per cent. Permanent way, etc. . . . 3 1/8 Brick and stone buildings. 1 1/2 Wood and iron buildings. 5 Rolling stock. . . . . 5 Labour charges are included, except in the case of permanent way. Scrap, less cost of demolition, is credited to renewals, as a set-off to the amount transferred to capital account to write out the value of the asset scrapped.
Natal Government Railways.	No fund is created for depreciation, but provision is made in working expenses for the upkeep of permanent way, rolling stock, and other assets. On the other hand, a sinking fund has been introduced, into which large sums are paid yearly with the object of liquidating the capital borrowed in a fixed period of years.	...	...
Cyprus Government Railway.	No depreciation is charged, but the costs of such extra expense will fall in the year that the renewals are required to be paid for from revenue.	Renewals funds are common practice. Certainly. This contingency is so obviously true that it needs no buttressing. No security whatever.	Provision not made.

Annexure No. 6 (continued).

Depreciation of Capital Assets. — Replies of various Railway Administrations as to the method of providing for Depreciation and Renewals of Capital Aassets.

ADMINISTRATION.	Question. Is any provision made in working expenses for depreciation of permanent way, rolling stock, and other assets to provide a fund for replacement on expiration of life? If not, how is such expenditure met as that on the relaying of a whole section or renewing a bridge with the same weight of material, or replacing locomotives, coaches, wagons, or machinery when life is exhausted?	Question. If no provision for depreciation is made at present, are you in favour of charging each year with something on account of that wear and tear which cannot be made good by ordinary maintenance, and do you consider in fixing such depreciation charges, obsolescence should be taken into account? If each year's working is not charged with some contribution for depreciation, and expenditure for replacements is charged to working expenses, do you find that it has a disturbing effect on expenditure and renders comparisons with other years of less value? Also what security have you that economies are not effected at the expense of capital assets?	Question. If provision is made for depreciation, please say how it is calculated. If on the estimated life of the assets, please give the yearly percentage of the cost which is set aside for each class of asset, and say whether labour charges are included in the cost on which depreciation is calculated. Also say how the value of any scrap is treated on replacement. Full information as to the working of the depreciation fund will be particularly valuable.
	Replies	**Replies.**	**Replies.**
New South Wales Government Railway.	No special fund is set apart for depreciation purposes, but what is practically equal to a depreciation account is that a certain amount of relaying and renewing of the permanent way and renewing of rolling stock and other works is provided and charged against working expenses each year.	Yes; to a certain extent. For instance, we provide for the wear, and tear that is going on year by year by charging to working expenses all capital works where the estimated cost is less than £100, and by renewing each year out of working expenses what is considered a fair thing. In the case of betterments or improvements the whole charge is debited to working expenses, and in this way it is considered we provide what to a large extent meets the ordinary wear and tear that is going on, and the value of the asset is maintained.	
Trinidad Government Railways.	No. In the one or two cases which have occurred of renewals the charge has been made against net revenue.	*a*) No provision is made at present. We consider there should be a renewal fund, fed from net revenue, as circumstances permit, after payment of fixed charges, which should be available to meet charge for any renewals which cannot be made good in the ordinary course of maintenance. Obsolescence should be included, and credit charges by sales, etc., placed to credit of renewals fund. *b*) Yes; very much so. Destroys comparisons for all useful purposes. Restrictions only on the employment of capital.	None.

Annexure No 7

Expenditure for Improvements. — Replies of various Railway Administrat

	Question.	Question.	Question.	Question.
ADMINISTRATION.	How is expenditure for improvements and replacements with heavier or better material treated in your accounts, such for instance as : 1° Replacement of bridges by stronger bridges. 2° Replacement of culverts by larger or stronger culverts. 3° Replacement of turntables by larger turntables. 4° Replacement of rails and other permanent way by heavier type. 5° Replacement of buildings by better structures. 6° Replacement of locomotives by heavier engines.	How is expenditure for rearrangement of lines or yards treated in your accounts *a*) where the mileage of track remains the same; *b*) were the mileage of track is increased?	Have you a separate allotment from railway profits for « betterment expenditure » — that is, expenditure for improvements the cost of which is not to be capitalised? If so, please say what classes of expenditure are charged to betterment and what classes are charged to capital account.	Is your system accounting such to make it impo ble to charge capi expenditure to w king, and vice vers
	Replies.	**Replies.**	**Replies.**	**Replies.**
East India Railway.	1°) 2°) 3°) and 5°) The general rule is that so far as the original structure is simply renewed without additions to its extent or to its strength (as in case of girders) or its efficiency or complexity (as in case of signals interlocking, etc.), the charge shall be borne by revenue, and the cost of any additions charged to capital. As regards bridges, capital is debited on basis of increased weight of girders or difference between cost of new girders and original cost of old girders replaced, whichever is less, revenue being debited with the balance of expenditure and credit with value of materials recovered. 4°) Rails : renewals should be sanctioned on a yearly or half-yearly mileage rate, which should include provision for ordinary maintenance. Increased weight in renewal would require special sanction. No charge to be made against capital unless the actual cost of the new rails is in excess of the original cost of those replaced and the new rail is also heavier than the old one, nor shall such charge bear a greater proportion to the cost of the rail replaced than that which the weight of the new rail bears to the weight of the old one. All charges for renewal of ordinary fastenings and chains to be made against revenue. Sleepers : additions to the number originally charged to capital to be charged to capital. The substitution of iron for wood not to be made unless specially authorised, the relative economy of wood and iron sleepers being open to considerable question. It may be agreed that revenue should bear one-third of the increased cost of substituted iron sleepers, and capital two-thirds. Ballast : all additions to the quantity of ballast originally charged to capital to be paid for by revenue after three years from the date of opening a new line, unless the contrary is specially sanctioned. 6°) Capital is debited on basis of increased tractive power, subject to the condition that the amount does not exceed the difference between the cost of the new and the original cost of the engine replaced.	*a*) Substantial improvements are debited to capital. *b*) Substantial improvements are debited to capital, including additional mileage of track.	All works costing less than Rs. 2,000 each, with a maximum of Rs. 25,000 in the half-year, which would otherwise be charged to capital are charged to revenue as new minor works. It may also be noted that the purchase price of the railway is being redeemed by annuities on a 50 years' basis, charged to net revenue account before arriving at divisible profits. This arrangement is to all intents and purposes a setting aside of a large share of the profits on a fund for betterment, as at the end of 50 years the original capital will be wiped out at the cost of revenue.	**Replies.**

Annexure No 7.

treatment of such Expenditure in their Accounts.

Question.	Question.	Question.	Question.	Question.
How is expenditure for rading and re-aligning the purpose of reduc- curves treated in your ounts?	To what account is expenditure for rebal-lasting or strengthening lines by materially in-creasing the quantity of ballast charged in your accounts?	How is the expense of removal of structures from one place to ano-ther charged in your ac-counts?	When a new line is opened is the expenditure for maintenance during the first twelve months (or less) charged to capital account or to working expenses? If the former, please say for what period capital account is charged.	If capital assets are scrapped and not replaced please say what adjust-ments are made in the books of your line. To what head are such reduc-tions in capital assets charged?
Replies.	**Replies.**	**Replies.**	**Replies.**	**Replies.**
o revenue.	We usually charge addi-tional ballast to revenue. A charge to capital would be altogether exceptional.	Charged to revenue, wor-king expenses.	Anything beyond the sanc-tioned specification for con-struction of the line is charged to revenue. The period is not unduly extended, but a good deal depends upon the season when the line is opened.	*a*) Capital is credited with scrap value, less cost of dis-mantling, provided there is no substitution. *b*) No adjustment is made.

Annexure No. 7 (continued.)

Expenditure for Improvements. — Replies of various Railway Administratio

ADMINISTRATION.	**Question.** How is expenditure for improvements and replacements with heavier or better material treated in your accounts, such for instance as : 1° Replacement of bridges by stronger bridges. 2° Replacement of culverts by larger or stronger culverts. 3° Replacement of turntables by larger turntables. 4° Replacement of rails and other permanent way by heavier type. 5° Replacement of buildings by better structures. 6° Replacement of locomotives by heavier engines.	**Question.** How is expenditure for rearrangement of lines or yards treated in your accounts *a*) where the mileage of track remains the same; *b*) were the mileage of track is in creased?	**Question.** Have you a separate allotment from railway profits for « betterment expenditure » — that is, expenditure for improvements the cost of which is not to be capitalised? If so, please say what classes of expenditure are charged to betterment and what classes are charged to capital account.	**Question.** Is your system o accounting such a to make it impossi ble to charge capita expenditure to wor king, and vice versa
	Replies.	**Replies.**	**Replies.**	**Replies.**
Eastern Bengal State Railway.	1°, 2° and 3°. Difference between old and new cost charged to capital. 4° A charge is made to capital in proportion to the weight of the heavier section of rails, the amount being limited to the difference between the original and new cost. 5° Difference between original and new cost. 6° A charge to capital is made on the increased dead-weight if the amount be over 10 per cent of the original cost of the locomotive; subject to the limit of the difference between the original and new cost.	*a*) To revenue entirely. *b*) To capital, the increased mileage : balance to revenue.	No.	Generally speaking Yes.
South Indian Railway.	1° Replacement of bridges by stronger bridges : The difference in cost between the new and the old girders at the current rate is a charge to capital, or the difference between the actual cost of the old and the estimated cost of the new, whichever is less: 2° Replacements of culverts by larger or stronger culverts : The difference in cost between the two is a charge to capital. 3° Replacement of turntables by larger turntables : See reply to No. 1° above. 4° Replacement of rails' and other permanent way by heavier type : See reply to No. 1° above. 5° Replacement of buildings by better structures : See reply to No. 2° above. 6° Replacement of locomotives by heavier engines : The difference between the cost of the old and the estimated cost of the new engines, or the difference in cost due to the proportionate excess in dead-weight of the two engines, calculated at the current rate, whichever is less, is chargeable to capital, provided the cost of the improvement is in excess of the original cost by more than 10 per cent.	*a*) To revenue. *b*) The difference in cost between the original and the increased mileage to capital.	A separate allotment for revenue expenditure is given. Cost of new works up to Rs. 1,000, of minor improvements, of alterations, and of renewals and maintenance is a charge to revenue. Cost of new works costing more than Rs. 1,000 each, and of substantial improvements is a debit to capital.	Yes.

Annexure No 7 (continued).

to the treatment of such Expenditure in their Accounts (continued).

Question.	Question.	Question.	Question.	Question.
How is expenditure for regrading and re-aligning or the purpose of reducing curves treated in your accounts?	To what account is expenditure for rebal-lasting or strengthening lines by materially increasing the quantity of ballast charged in your accounts?	How is the expense of removal of structures from one place to another charged in your accounts?	When a new line is opened is the expenditure for maintenance during the first twelve months (or less) charged to capital account or to working expenses? If the former, please say for what period capital account is charged.	If capital assets are scrapped and not replaced please say what adjustments are made in the books of your line. To what head are such reductions in capital assets charged?
Replies.	**Replies.**	**Replies.**	**Replies.**	**Replies.**
To revenue.	To capital up to a certain limit of cost per mile: above that limit to revenue.	To revenue.	...	...
Charged to revenue, working expenses.	Ordinary ballasting of the line is a charge to revenue, working expenses. Any substantial increase in the depth of ballast to what is already laid as required is a charge to capital.	To revenue, working expenses.	The ordinary rule is that all maintenance charges from the date of opening of a line to traffic are a debit to capital for the first twelve months.	If a work be abandoned and not replaced, the original cost remains at debit of capital. Any materials returned to stores will be credited to capital. If a work be abandoned consequent on the construction of another work or in connection with the rearrangement of the existing work, the original cost of the abandoned portion is a debit to revenue, which will receive credit for materials returned to stores.

Annexure No 7 (continued).

Expenditure for Improvements. — Replies of various Railway Administratio

ADMINISTRATION.	Question. How is expenditure for improvements and replacements with heavier or better material treated in your accounts, such for instance as : 1° Replacement of bridges by stronger bridges. 2° Replacement of culverts by larger or stronger culverts. 3° Replacement of turntables by larger turntables. 4° Replacement of rails and other permanent way by heavier type. 5° Replacement of buildings by better structures. 6° Replacement of locomotives by heavier engines	Question. How is expenditure for rearrangement of lines or yards treated in your accounts *a*) where the mileage of track remains the same; *b*) were the mileage of track is increased?	Question. Have you a separate allotment from railway profits for « betterment expenditure » — that is, expenditure for improvements the cost of which is not to be capitalised? If so, please say what classes of expenditure are charged to betterment and what classes are charged to capital account.	Question. Is your system o accounting such a to make it impossi ble to charge capita expenditure to wor king, and vice versa
	Replies.	**Replies.**	**Replies.**	**Replies.**
Assam Bengal Railway.	Such expenditure is debited to capital, and the original cost written back to revenue.	...	No.	...
Ceylon Government Railway.	In all cases of replacements, etc., where the appreciation is more than Rs. 500 over original cost the appreciation is added to capital account; replacements involving an expenditure of less than Rs 500 over original cost are met from revenue.	...	We have no separate « betterment » account.	This is provided against by a carefu scrutiny of expenditure by the accountant.
Federated Malay States Railway.	All such expenditure, except purchase of new and heavier locomotives, appears under the heading « special services, revenue account, » and is included in the ordinary working account for the year under the particular department to which the expenditure refers.	This is treated in the same way as the expenditure referred to in the previous question.	*a*) No; such expenditure is estimated for and approved by Government. *b*) This is decided by Government when going through my draft estimates for the coming year. There is no general rule in force, the object is to keep the capital account down as much as possible.	Impossible, and i never done.
Cape Government Railways.	1° and 2° Partly capital, partly open lines. 3° Open lines. 4° Capital and open lines. 5° Capital. 6° Partly working, and partly depreciation.	*a*) Open lines. *b*) Capital.	No.	No.

Annexure No 7 (continued).

to the treatment of such Expenditure in their Accounts (continued).

Question.	Question.	Question.	Question.	Question.
How is expenditure for egrading and re-aligning r the purpose of reduc- g curves treated in your ccounts?	To what account is expenditure for rebal- lasting or strengthening lines by materially in- creasing the quantity of ballast charged in your accounts?	How is the expense of removal of structures from one place to ano- ther charged in your ac- counts?	When a new line is opened is the expenditure for maintenance during the first twelve months (or less) charged to capital account or to working expenses? If the former, please say for what period capital account is charged.	If capital assets are scrapped and not replaced please say what adjust- ments are made in the books of your line. To what head are such reduc- tions in capital assets charged?
Replies.	**Replies.**	**Replies.**	**Replies.**	**Replies.**
...	...	...	Such charges are debited to revenue from the date the line is opened for traffic.	...
Expenditure for regrading d reducing curves is char- d against revenue.	Reballasting is charged against revenue.	...	Ordinary maintenance ex- penditure on account of new lines is charged against reve- nue, but heavy work bringing the line up to working condi- tion is charged against capital.	...
Capital account.	Engineering department, revenue account.	Capital or revenue ac- count, according to circum- stances.	Charged to maintenance from date of opening for traffic.	We do not make such ad- justments.
Open lines.	Maintenance.	Maintenance.	Charged to maintenance from opening of line.	Capital is not reduced.

Annexure No. 7 (continued).

Expenditure for Improvements. — Replies of various Railway Administrat

ADMINISTRATION.	**Question.** How is expenditure for improvements and replacements with heavier or better material treated in your accounts, such for instance as : 1° Replacement of bridges by stronger bridges. 2° Replacement of culverts by larger or stronger culverts. 3° Replacement of turntables by larger turntables. 4° Replacement of rails and other permanent way by heavier type. 5° Replacement of buildings by better structures. 6° Replacement of locomotives by heavier engines.	**Question.** How is expenditure for rearrangement of lines or yards treated in your accounts *a*) where the mileage of track remains the same; *b*) were the mileage of track is increased?	**Question.** Have you a separate allotment from railway profits for « betterment expenditure » — that is, expenditure for improvements the cost of which is not to be capitalised? If so, please say what classes of expenditure are charged to betterment and what classes are charged to capital account.	**Question.** Is your system accounting such to make it impos ble to charge capi expenditure to w king, and vice vers
	Replies.	**Replies.**	**Replies.**	**Replies.**
Central South African Railways.	If a replacement is rendered necessary, on account of the original asset being worn out, the cost of providing a new one is charged to capital account and the original value of the old asset is written out of capital account by a transfert from renewals fund. If a heavier type of rail is being substituted for a lighter one, the difference in cost between the old and the new (material only) is charged to capital account. The labour in effecting the change is charged to betterment or working. In strengthening bridges the cost is charged to betterment, unless the replacement is governed by the principle mentioned above.	*a*) The cost of moving track from one part of a station yard to another is charged to working. *b*) If additional tracks are provided in connection with the re-arrangement, the cost of the additions is charged to capital.	There is one allotment from net revenue annually for "betterment" purposes. A portion of this allotment is transferred to capital to meet expenditure on new capital works. Expenditure on the acquisition of new assets is charged to capital, and betterment is charged with the cost of effecting improvements to existing works.	It is hardly possi for capital expendit to be charged to wo ing or vice versa, as one instance the au exercised would rev the wrong allocati and in the other capital allocations agreed by the Ch Accountant and Audi before being passed the Railway Board.
Natal Government Railways.	Improved value only debited to capital.	Debited capital if over £100 in value, otherwise charged to betterment.	Yes, for small works under £ 100 in value.	...
Cyprus Governement Railways.	Provision would require to be made in yearly estimates, but the point has not yet risen in this country.	This point has not arisen.	No.	All expenditure capital account is sa tioned by the Secreta of State; the local au tor, having been advi of such sanction, l complete control.

Annexure No. 7 (continued)

o the treatment of such Expenditure in their Accounts (continued).

Question.	Question.	Question.	Question.	Question.
How is expenditure for egrading and re-aligning r the purpose of reduc- g curves treated in your ccounts?	To what account is expenditure for rebal- lasting or strengthening lines by materially in- creasing the quantity of ballast charged in your accounts?	How is the expense of removal of structures from one place to ano- ther charged in your ac- counts?	When a new line is opened is the expenditure for maintenance during the first twelve months (or less) charged to capital account or to working expenses? If the former, please say for what period capital account is charged.	If capital assets are scrapped and not replaced please say what adjust- ments are made in the books of your line. To what head are such reduc- tions in capital assets charged?
Replies.	**Replies.**	**Replies.**	**Replies.**	**Replies.**
egrading is charged to pital. Re-aligning is also arged to capital, with a rresponding credit from newals for the value of the rks abandoned.	Permanent betterment.	To working expenses.	Working expenses.	*a*) The original value of the asset withdrawn is written out of capital account. *b*) To renewals fund.
o capital account.	Maintenance department.	To the department reques- ting execution of work.	To working expenses.	When capital assets are sold, the value realised is credited to capital account.
Has not arisen, but probably ould be provided for in cur- nt estimates.	Current estimates.	Has not arisem.	Charged to working expen- ses immediately opened for traffic.	The Cyprus railway has been built out of the proceeds of an Imperial loan. 1 per cent. per annum is credited to a sinking fund. In fifty years the r ilway cost, principal and inte- rest will have been paid. All capital assets scrapped are to be replaced from cur- rent estimates (revenue).

*

Annexure No. 7 (continued).

Expenditure for Improvements. — Replies of various Railway Administrat

ADMINISTRATION.	**Question.** How is expenditure for improvements and replacements with heavier or better material treated in your accounts, such for instance as : 1° Replacement of bridges by stronger bridges. 2° Replacement of culverts by larger or stronger culverts. 3° Replacement of turntables by larger turntables. 4° Replacement of rails and other permanent way by heavier type. 5° Replacement of buildings by better structures. 6° Replacement of locomotives by heavier engines.	**Question.** How is expenditure for rearrangement of lines or yards treated in your accounts *a*) where the mileage of track remains the same; *b*) were the mileage of track is in creased?	**Question.** Have you a separate allotment from railway profits for « betterment expenditure » — that is, expenditure for improvements the cost of which is not to be capitalised? If so, please say what classes of expenditure are charged to betterment and what classes are charged to capital account.	**Question.** Is your system accounting such to make it impos ble to charge capi expenditure to w king, and vice vers
New South Wales Government Railways.	**Replies.** As a general rule, to working expenses, but in a few cases, where the betterments are very exceptional, a portion is charged to capital.	**Replies.** To working expenses where the mileage of the track remains the same ; where the mileage of the track is increased, if the amount exceeds £100, it is charged to capital; under that amount to working expenses.	**Replies.** No. This is charged to ordinary working expenses schedules. All classes of expenditure not charged to capital are charged to working expenses.	**Replies.** ...
Trinidad Government Railway.	1° and 2° Net revenue. 3° and 4° Working expenses : renewals. 5° Capital and net revenue. 6° None.	*a*) Working Expenses. *b*) Net revenue and capital.	No. Additions and improvements not renewals are charged to capital or net revenue.	No.

Annexure No. 7 (continued).

the treatment of such Expenditure in their Accounts (continued).

Question.	Question.	Question.	Question.	Question.
How is expenditure for rading and re-aligning the purpose of reduc- curves treated in your ounts?	To what account is expenditure for rebal-lasting or strengthening lines by materially in-creasing the quantity of ballast charged in your accounts?	How is the expense of removal of structures from one place to ano-ther charged in your ac-counts?	When a new line is opened is the expenditure for maintenance during the first twelve months (or less) charged to capital account or to working expenses? If the former, please say for what period capital account is charged.	If capital assets are scrapped and not replaced please say what adjust-ments are made in the books of your line. To what head are such reduc-tions in capital assets charged?
Replies.	**Replies.**	**Replies.**	**Replies.**	**Replies.**
he cost of the old work is rged to working expenses; additional work is char- to capital.	As a general rule, to wor-king expenses, but in a few exceptional cases, where the line is not properly constructed in the first ins-tance, a portion is charged to capital.	To working expenses.	Il all cases the cost of main-tenance is charged to working expenses.	Working expenses is debi-ted and capital credited with the original cost.
rking expenses.	Working expenses.	Working expenses.	Capital maintains up to handing over in good condi-tion, then working expenses maintains.	The question has not arisen. Surplus plant after construc-tion has been sold and the proceeds credited to capital account. There should be a ledger account, to which capi-tal credits might be put in reduction of the capital value of the concern.

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REPORT N° 2

(Great Britain)

By W. M. ACWORTH.

When I am invited to report for the International Railway Congress on the subject of Railway Statistics in the United Kingdom under the two heads of *a)* principles of statistics of railways in operation, and *b)* uniform classification of working expenses, I am reminded of a time-honoured story. An author once wrote a book on the zoology of Ireland. One chapter was headed " Snakes in Ireland ", and the contents of the chapter were the words " There are no snakes in Ireland ". Similarly there are in the United Kingdom no principles of statistics of railways in operation, and there is no uniform classification of working expenses. I might therefore end my paper at this point, for it would be an absolute waste of time to discuss such statistics as at present exist for our English railways, to point out their lack of principle, the want of form and symmetry in such statistics as do exist, and the still more important *lacunæ* which our present statistics, such as they are, leave unfilled. As for uniformity of classification, one instance may suffice. The heading of expenditure entitled " maintenance of way, works and stations " is, in our existing forms, divided into four subheads. The chief engineer of one of our great railways a few years ago described these four sub-heads as four paper baskets, which stood by the side of the table of the engineer of each railway company. It was, he said, a matter of pure accident into which of the four baskets any particular item of expenditure happened to be thrown.

But in order that the Congress may not be without some information as to the

position of British railways from the statistical point of view, it is perhaps worth while to give some account of the history of the subject. More than forty years ago, in the year 1868, an Act of Parliament required all railway companies to prepare and publish, half year by half year, a report with accounts and statistics according to forms laid down in detail by the Act itself. The forms prescribed by the Act of Parliament could only be altered by the Board of Trade with the consent of the company concerned. Naturally therefore, as a change could not be generally introduced without the consent of every company, the forms prescribed by this Act have remained substantially unchanged from that day to this. Three years later, however, a further Act required the railway companies to furnish annually certain further information to the Board of Trade. By an amending Act passed in the year 1888, the Board of Trade was given power to add to and vary these returns as they from time to time might think expedient. The Board have, however, hitherto made very little use of this power to obtain fuller information. The most important instance, perhaps, occurred in the year 1903, when for the first time they called for statistics as to the length of siding mileage, which, up to that date, no company published, and which some at least of the more important companies did not actually possess, even for their own information.

For many years there have been complaints both of the inadequacy and of the inaccuracy of the information furnished. Complaints of the former nature have mainly been made by outsiders, for the idea that a railway is a private undertaking, like a grocer's or a butcher's shop, and that the public have no right to the information is deeply ingrained in the English railway mind. But the railway men themselves have frequently complained on the ground of the inaccuracy. The schedules of the old forms of forty years ago are of course quite incapable of finding room for all the complexities of modern railway business, and in the absence of any controlling authority to decide to which of the existing schedules a given expenditure can best be allocated, no one heading means the same to all the companies, and all comparisons between one company and another of expenditure for what are nominally identical objects, are vitiated in consequence.

One or two instances may be given of the impossibility of putting the new wine into the old bottles. Within the last thirty or forty years, our railway companies have embarked very large amounts of money in hotels and in steamboats, and the practice of one company running over the line of another company has very greatly increased. The capital expended on hotels, and it must amount to many millions sterling, has hitherto been returned as " expenditure on lines open to traffic ". But the revenue receipts and expenditure from these same hotels does not appear under the head of traffic receipts and expenditure, but is entered separately as " miscellaneous ". Again, in the case of steamboat traffic, the receipts in some cases have been entered as railway receipts and have accordingly, when divided by the train mileage run, unduly inflated the receipts per train mile, as compared with those of another company which kept its steamboat receipts and its railway receipts

separate.' Once again, the gross railway receipts of a company have been made up of three items, *a*) receipts earned by its own trains on its own line ; *b*) its portion of the receipts earned byi ts own trains on another company's line ; *c*) its portion of the receipts from trains of other companies run over its line. And this hotch-potch figure has been used as the sum to give, when divided by the gross receipts, the receipts per train mile. These instances, and they are only instances which might be multiplied indefinitely, will perhaps suffice to show how dangerous it has hitherto been to attempt to compare English railways amongst themselves and still more with those of other countries on the basis of the published figures.

In June 1906, the President of the Board of Trade appointed a Committee " to consider and report what changes, if any, are desirable in the form and scope of the accounts and statistical returns (Capital, Traffic, Receipts and Expenditure) rendered by railway companies under the Railway Regulation Act. " That Committee sat for three years, and they made a report recommending an entirely new form of accounts and statistical returns. This form, which is printed in full as an appendix to this paper, was unanimously agreed to by the Committee. Attention may be called to the main reforms therein recommended. It is proposed :

1° That the present duplication of reports issued to shareholders and returns made to the Board of Trade be done away with, as the proposed new forms of accounts and statistics include all the information hitherto furnished to the Board of Trade additional to that given to the railway shareholders ;

2° That the reports be made yearly instead of half-yearly ;

3° That the reports be divided into two parts : *a*) accounts proper, and *b*) statistical returns ;

4° That uniformity in the keeping of the accounts and statistics in future be provided for by the appointment of a standing committee to decide what is the proper heading under which entries should be made, and to see that all the companies make their entries accordingly ;

5° That separate accounts be kept of all the various businesses carried on by railway companies — docks, steamboats, hotels, canals and the like, so that in future it may be possible to disentangle the capital expenditure and also the income receipts and expenditure of the railway proper from the figures of the railway company's undertaking as a whole ;

6° That provision, too elaborate to be more than alluded to here, be made to secure that in future the capital of the company be brought into relation with the property owned, and that the expenditure be brought at least into some relation with the work done and the receipts therefrom ;

7° That statistics be furnished which, if not so full as those given in most other countries, will be at least very much fuller than anything that has hitherto been published in this country.

On looking at the new forms proposed for adoption by the Committee, it will be observed that very little has been done in the direction of making the English classification of working expenses correspond with those of other countries. However desirable such uniformity may be, and the present writer would be one of the last to underrate the desirability, the Committee (and I speak here as a member of it) found it practically impossible to make any steps in this direction. To bring English railway accounts into line with those of other countries would necessarily mean a complete break with the past and an entire change in English methods of railway book-keeping. Such a change could hardly be introduced without the cordial co-operation of the railway companies themselves, and this co-operation the companies, rightly or wrongly, were not prepared to give. It was impossible for the Committee, therefore, to avoid taking existing English accounts as a basis and recommending their improvement along traditional lines. If the Report of the Committee is approved and acted upon by the Government and legislation passed to secure the adoption of the forms recommended by the Committee, we shall get a uniform classification of working expenses throughout the United Kingdom. But it must be left for a new set of men under new conditions to work towards the still more important aim of a uniform classification of working expenses throughout the civilised world.

Dealing with the other head of the subject, namely principles of statistics of railways in operation, attention may first be called to forms Nos. 1 to 7, which are headed Capital Accounts. These accounts are, I believe, fuller than the corresponding accounts of the railways in any other country, and the reason, as usual in England, is a historical one. In no other country, as far as I am aware, where the railways are private enterprises, is the creation and issue of fresh capital subject to the constant and detailed control of Parliament. A British railway company can only issue capital at such times, and in such amounts, and for such purposes, as may be specifically authorised by Parliament in each individual case. The first section of the accounts, therefore, sets out, in full and in great detail, first the authority for each capital issue; secondly, the extent to which that authority has been exercised; and thirdly, the purposes to which that capital, so authorised and issued, has been devoted. For the particular year to which the accounts relate, the details are further elaborated, and the capital accounts conclude with two forms, the first of which (No. 6) gives under appropriate headings an estimate of further expenditure on capital account which the company has in front of it; while form No. 7 shows what unexhausted capital powers the company has available to meet the contemplated expenditure.

The next group of forms (Nos. 8 to 19) are headed "Revenue Accounts". In forms Nos. 8 and 9, the accounts of the undertaking as a whole are dealt with in a summary form. The total receipts of all the various branches of the business, railway, steamboats, canals, docks, etc., are brought together; the total net income is established, and the proposed appropriation thereof to the payment of interest, to

dividend and to reserve funds set out in logical order. Accounts Nos. 10 to 17 form a complete series, giving receipts and expenditure in respect of each separate business of the company. No. 11, for instance, gives receipts and expenditure in respect of omnibuses and other passenger vehicles not running on the railway. No. 13 receipts and expenditure in respect of steamboats, and so on. These accounts, however, which only concern the subsidiary undertakings, have been kept as concise as possible, and need not be further dealt with here. The important account is No. 10, Receipts and Expenditure in respect of Railway Working.

Just as account No. 8 was a summary of the receipts and expenditure of the whole undertaking, No. 10 is really only a summary of the receipts and expenditure of the railway proper. Sub-accounts of expenditure, under the main heads of maintenance of way, maintenance of rolling stock, locomotive expenses, traffic expenses, etc., and to some extent sub-accounts of receipts, are given as supplemental to account No. 10, under the time-honoured English name of " abstracts ". It will be seen by anyone who is acquainted with the form of accounts at present used in England, and who studies the proposed new expenditure forms, that, while they are by no means so full as those in use in some other countries, they constitute a vast improvement on anything hitherto existing in this country. Abstract A, " Maintenance of Way and Works ", for instance, provides for twenty separate entries, where the old accounts provided for only six; and it will for the first time show in reasonable detail where the money spent has actually gone; while, when taken with the corresponding statistical return (No. X) of the work done and the materials used, it will give a fair idea of the value that has been received given in return. Moreover, and this point need not be repeated at every stage, by its provision of this large number of separate headings, coupled with the proposal for a standing committee to rule on questions of interpretation from time to time, it takes reasonable precautions to insure that the accounts of the different companies shall be in future fairly uniform, and comparable under their separate headings, the one with the other.

The two following abstracts, B and C, deal respectively with the maintenance and renewal of rolling stock and with locomotive running expenses. The traditional English organization, by which the same department maintains the locomotives and controls their working out on the road, made it impossible to adopt the logical division, which would naturally be to put all running expenses together. But at least something has been done in this direction. Running expenses of locomotives have for the first time been definitely separated from maintenance expenses; and in the following abstract D, Traffic Expenses, the wages of guards, and the cleansing, lubricating and lighting of vehicles, have for the first time been set out as separate items So that in the future, by adding these items to the locomotive running expenses it will be possible to get some rough idea of the out-of-pocket cost of running a train. Further, it will be noted that rolling stock cost is to be divided under four main heads : additions to stock, replacement of stock,

repairs of stock, and general shop cost. Once more a statistical return, No. XI, gives a record of the work done, corresponding with the payments shown in the accounts as made.

At this point notice may be taken of the fact that, on the expenditure side of the account, no distinction is made between goods and passenger traffic. No doubt any attempt to distinguish between passenger-cost and goods-cost must be more or less inaccurate, and must to a considerable degree rest on estimate and apportionment. In the view of the present writer, however, the division, imperfect though it be, is valuable, and ought to be made. But reports of Committees must always be of the nature of a compromise, and the view of the railway companies, that as a rule information is better withheld than given, coupled with the view of the precise statistician, that estimates should not appear in accounts purporting to record actual arithmetical facts, have in this case not unnaturally prevailed.

One other sub-account, Abstract F, must be noticed on the expenditure side. It is really an expense account, though it appears among the receipts. It is headed " Collection and delivery of parcels and goods and other parcels traffic by passenger train ". It is no doubt generally known that, on English railways, the rates for merchandize traffic normally include, not merely railway carriage, but collection from the consignor and delivery to the consignee, no separate charge being made for these latter services. Hitherto the practice of the companies has been, to set out their gross receipts from goods traffic; then to show the cost of collection and delivery of all traffic, whether by goods train or by passenger train, as a deduction therefrom, and to enter the balance in their accounts as goods traffic receipts. In future, the expenses of collection and delivery will be set out in detail; the amounts charged against passenger-train-traffic and goods-train-traffic respectively will also be stated; and these respective amounts deducted from passenger-train-receipts and goods-train-receipts as the case may be.

The weakest point in the proposed new accounts — accounts proper as distinguished from statistics — is undoubtedly to be found on the receipts side of table No. 10. Objections that were found, or at least believed, to be insuperable were urged against any detailed division of the railway receipts. And in the upshot the Committee have been contented to recommend a very bald list of entries. Passenger receipts are all lumped together under three main heads : Ordinary tickets, first, second and third class, season tickets, first, second and third class; and workmen's tichets. The phrase " ordinary tickets," though sanctioned by long usage, is entirely misleading. It includes not merely single tickets isued at the normal mileage fare and ordinary return tickets, but also hundreds of millions of tickets at rates frequently not exceeding a farthing a mile, excursion tickets, market tickets, special golfers', anglers', bicyclists' tickets, soldiers' and sailors' tickets, week-end tickets, privilege tickets, and other tickets at exceptional fares much too numerous to specify in detail.

In the case of goods traffic the lack of detail is even more painfully apparent.

Merchandize receipts — and they amount on the British railways to £30,000,000 per annum — are given in one lump, no attempt whatever being made even to distinguish between what the Germans call *Stückgut* and large consignments. Livestock; coal, coke and patent fuel; and other minerals : each have a separate line to themselves. And that is all.

The statistical returns (Nos. 13, 14 and 15) relating to the traffic receipts, do not carry matters much further. In the case of passengers, it is proposed to state the number under the same headings of ordinary, season-ticket and workmen, and also — and this is undoubtedly a valuable addition — the number originating on each company's system. Our Board of Trade reports of the number of passengers conveyed on British railways have hitherto been merely a total of the number of passengers conveyed by each several company, and, as in London and other great towns a passenger travelling only three or four miles may quite well use the systems of three separate companies, the number of actual passenger journeys made at ordinary fares is probably one or two hundred millions less than the Board of Trade figures. A similar column, "Tonnage originating on the Company's system" is given, and for the same reason, in the statistical table dealing with goods traffic. Statistical table No. 15, to be filled in by stating separately "the tonnage of the principal articles of traffic originating or terminating on each railway company's system and carried in consignments of not less than two tons," will no doubt be of some use in indicating, at least in outline, the nature of each company's main traffic, and the proportion of the whole which is carried in consignments of less than two tons.

But this brings me to a point on which I would desire, though I cannot entirely ignore it, to say as little as possible. So much of the report of the proposed accounts and statistical returns as have been dealt with hitherto represents the unanimous recommendation of the Committee. But on the question whether figures of ton mileage, passenger vehicle mileage, and wagon mileage, should be compiled and published, the Comittee were sharply divided. It is no doubt commonly known that English railway companies do not, with one conspicuous exception, compile such figures. According to their official statements the compilation of any such figures is useless and unreasonably expensive, and their publication is misleading and in the highest degree objectionable. I shall not of course attempt to discuss the question here. To tell a railway man of any other country, who would as soon think of doing without these figures as a doctor would think of dispensing with a clinical thermometer, that they are valuable, would be merely absurd; while to attempt to argue with the English railway men, who have already made up their minds (though possibly on grounds other than the extremely inadequate reasons which alone they adduce in public), would be equally waste of space. But the history of the matter before the Committee is worth recording. The Committee consisted of nine members. Three of them represented the railway companies; and their atti-

tude I have already indicated. Three members had before their appointment publicly asserted the necessity for these figures. The remaining three members, among whom was the Chairman, approached the subject with no preconceived opinions. After much discussion and hearing a considerable number of witnesses, only one of whom, however, was not an Englishman, the two groups of three on either side remained not unnaturally of the same opinion still, while the centre three came to an intermediate conclusion. They reported in effect that the result of the evidence and discussion was that the statistics in question would be of value; that the cost of compilation would not be great; and they ended in "recommending this class of statistics to the careful consideration of those responsible for railway working in this country, with a view to seeing whether they could be more widely introduced." But they went on to say that "a large part of their usefulness might be lost, if their compilation resulted solely from compulsion," and that "there is not sufficient ground for insisting on their being compiled by all companies, unless and until they come to be adopted by a considerable number of the important companies".

From this conclusion the two groups on either side recorded their dissent. The three railway members put in a reservation claiming that these statistics were useless. The three remaining members put in a reservation to the effect that there was no ground for treating these returns differently from all other returns. If compulsion was to be applied in one case, why not in all? They knew no reason "why a large part of their usefulness might be lost if their compilation resulted from compulsion," and they further expressed the opinion that the information thereby given was information to which Parliament and the public, all well as the shareholders, kad a right to have access. In order to give effect to their opinion, they accordingly recommended the incorporation, along with the forms given in Appendix 1 of their report, of the additional set of forms published in Appendix 2.

It now only remains to be seen what attitude the Board of Trade and Parliament will adopt in reference to the matter.

APPENDICES.

APPENDIX 1.

Form of accounts and statistical returns.

PART I. — FINANCIAL ACCOUNTS.

Year 19 .

(*Nos. 1 to 7, capital accounts.*)

No. 1*a*. — Nominal capital authorised and created by the company.

Acts of parliament or certificates of the board of trade.	Capital authorised.			Capital created.			Balance.		
	Shares and stock.	Loans or debenture stock.	Total.	Shares and stock.	Loans or debenture stock.	Total.	Shares and stock.	Loans or debenture stock.	Total.
	£	£	£	£	£	£	£	£	£
I. Acts or certificates conferring capital powers which have been fully exercised.									
Totals. . .									
II. Acts or certificates conferring capital powers which have not yet been fully exercised.									
[*Each such act or certificate to be stated here separately in order of date.*]									
1.									
2.									
etc.									
Total. . .									

No. 1*b*. — Nominal capital authorised, and created by the company jointly with some other company.

Acts of parliament.	Capital authorised.			Capital created.			Balance.		
	Shares and stock.	Loans or debenture stock.	Total.	Shares and stock.	Loans or debenture stock.	Total.	Shares and stock.	Loans or debenture stock.	Total.
	£	£	£	£	£	£	£	£	£

Year 19 .

No. 1*c*. — Nominal capital authorised, and created by some other company on which the company either jointly or separately guarantees fixed dividends.

Acts of parliament.	Capital authorised.			Capital created.			Balance.		
	Shares and stock.	Loans or debenture stock.	Total.	Shares and stock.	Loans or debenture stock.	Total.	Shares and stock.	Loans or debenture stock.	Total.
[NOTE.— *It should be stated in each case whether the dividend is guaranteed jointly with some other company or companies (the names of which should be given) or separately.*]	£	£	£	£	£	£	£	£	£

No. 2. — Share capital and stock created, as per statement No. 1*a*, showing the proportion issued.

Description.	Amount created.	Amount issued.	Nominal additions to or deductions from capital.	Amount on which dividend is payable.	Amount which does not rank for dividend until a future date.	Calls in arrear.	Amount uncalled.	Amount unissued.
[*Each class of shares and stock to be stated in order of date of creation, with the preferential or fixed dividends, if any, to which it is entitled, and any other conditions attached to it.*]	£	£	£	£	£	£	£	£
Total. . .								

Note. — A column to be provided where necessary between " Amount created " and " Amount issued " to show " Additional stock issued to provide authorised money ".

Year 19 .

No. 3. — Capital raised by loans and debenture stock.

	Raised by loans.					Raised by issue of debenture stocks.						Total raised by loans or debenture stocks.
	At per cent.	At per cent.	At per cent.	At per cent.	Total loans.	Amount of stock.	Nominal additions or deductions on conversion.	Existing amount of stock. At per cent.	At per cent.	At per cent.	Total debenture stock.	
	£	£	£	£	£	£	£	£	£	£	£	£
Existing at												
Existing at												
Increase												
Decrease												

Total amount authorised to be raised by loans and debenture stocks in respect of capital created as per statement No. 1*a*		
	£	
Less : Amount created but not yet available		
Reduction of borrowing power in respect of interest paid out of capital.		
Capitalized value of rent charges, annuities or feu duties, in accordance with section 5 of the Lands Clauses Consolidation Acts Amendment Act, 1860		
Other deductions, if any		
Total deductions. . .		
Total amount raised by loans and debenture stock as above		
Balance being available borrowing powers at.		

Year 19 .

No. 4. — Receipts and expenditure on capital account.

Dr. Cr.

To expenditure.	Amount expended to...	Amount expended during year as per No. 5.	Total.	By receipts.	Amount received to...	Amount received during year.	Total.
	£ s. d.	£ s. d.	£ s. d.		£ s. d.	£ s. d.	£ s. d.
Lines open for traffic							
Lines not open for traffic :							
New lines				Shares and stocks (No. 2)			
Widening of existing lines				Loans (No. 3)			
Lines leased				Debenture stock (No. 3)			
Lines, jointly owned							
— — leased							
Rolling stock							
Manufacturing and repairing works and plant :							
Land and buildings							
Plant and machinery							
Total capital expended upon railway				£			
Horses				Premiums on shares and stocks			
Road vehicles employed in the collection and delivery of parcels, goods, and passengers :				Premiums on debenture stock			
1. Goods and parcels road vehicles				Total premiums			
2. Passenger road vehicles.							
Steamboats				Discounts on shares and stocks			
Canals							
Docks, harbours and wharves				Discounts on debenture stock			
Hotels							
Electric power stations, etc.				Total discounts			
Land, property, etc., not forming part of the railway or stations :							
a) Used in connection with railway working							
b) Not used in connection with railway working							
Other industries : (To be stated separately.)							
Subscriptions to other companies (for details see table below, No. 4 (*a*))				Balance of premiums and discounts			
Special items							
TOTAL EXPENDITURE				TOTAL RECEIPTS			
To balance				By balance			
		TOTAL				TOTAL	

No. 4*a*. — Subscriptions to other companies.

Name.	Amount.	Nature of security or investment.
	£	
a) Railway companies	...	...
b) Other	...	...

Year 19 .

No. 5. — Details of capital expenditure for year ending . . . .

—	Land and compensation.	Construction of way & stations, engineering, &c.	Law charges and parliamentary expenses.	Total.
	£ s. d.	£ s. d.	£ s. d.	£ s. d
Purchase of railways (particulars) . .				
Lines belonging to the company open for traffic (particulars)				
Lines belonging to the company not open for traffic:				
New lines (particulars)				
Widenings of and additions to existing lines (particulars) . .				
Lines leased (particulars)				
Lines jointly owned (particulars) . .				
Lines jointly leased (particulars) . .				
Rolling stock:				
Locomotives	(Number and type of each description to be shown in accordance with rolling stock returns).			
Coaching vehicles				
Wagons				
Service vehicles				
Manufacturing and repairing works and plant (particulars)				
Horses				
Road vehicles employed in the collection and delivery of parcels, goods, and passengers (particulars)				
Steamboats (particulars)				
Canals (particulars)				
Docks, harbours, and wharves (particulars)				
Hotels (particulars)				
Electric power stations, etc. (particulars)				
Land, property, etc., not forming part of the railway or stations:				
a) Used in connection with railway working (particulars)				
b) Not used in connection with railway working (particulars)				
Subscriptions to other companies (particulars)				
a) Railway companies				
b) Other				
Special items (details to be given)				
Total capital expenditure for the year. . .				

Year 19 .

No. 6. — Estimate of further expenditure on capital account.

Expenditure to date on principal works in progress.	—	Estimated further expenditure.		
		During the year ending. . . .	Subsequently until completion.	Total.
£		£	£	£
	Purchase of railways (particulars) . .			
	Lines belonging to the company open for traffic (particulars)			
	Lines belonging to the company not open for traffic:			
	New lines (particulars).			
	Widenings of and additions to existing lines (particulars). . .			
	Lines leased (particulars)			
	Lines jointly owned (particulars). . .			
	Lines jointly leased (particulars). . .			
	Rolling stock			
	Manufacturing and repairing works and plant.			
	Steamboats			
	Canals			
	Docks, harbours, and wharves . . .			
	Hotels			
	Electric power stations, etc.			
	Subscriptions to other companies. . .			
	Special items			
	Miscellaneous			
	Total. . .			
	Works not yet commenced and in abeyance			

No. 7. — Capital powers and other assets available to meet further expenditure on capital account.

	£	£
Stock, share and loan capital authorised but not yet created (as per statement No. 1 (*a*)). .		
Stock and share capital created but not yet received (as per statement No. 2):		
Calls in arrear		
Amount uncalled		
Amount unissued		
Loan capital created but not yet available (as per statement No. 3)		
Available borrowing powers (as per statement No. 3)		
Add or Deduct { balance at { Credit or Debit } (as per capital account No. 4)		
Total. . .		

Year 19 .

(*Nos. 8 to 19, revenue accounts.*)

No. 8. — Revenue receipts and expenditure of the whole Undertaking.

See statement.		Gross receipts.	Expenditure.	Net receipts.	Year 19 . Gross receipts.	Year 19 . Expenditure.	Year 19 . Net receipts.
		£ s. d.	£ s. d.	£ s. d.	£	£	£
10	Railway						
11	Omnibuses and other passenger vehicles not running on the railways						
12	Refreshment rooms and cars where catering is carried on by the company . . .						
13	Steamboats						
14	Canals						
15	Docks, harbours and wharves						
16	Hotels						
17	Other separate businesses carried on by the company (in detail)						
	Total. . £						
	MISCELLANEOUS RECEIPTS (NET):						
	Rents from houses and lands						
	Rents from hotels						
	Other rents including lump-sum tolls						
	Interest and dividends from investments in other Companies (in detail)						
	Transfer fees						
	General interest						
	Special items						
	Total net income. . .						

Year 19 .

No. 9. — Proposed appropriation of net income.

—	—	Year 19 .
	£ s. d.	£ s. d.
Balance brought forward from last year's account		
Net income (as per statement No. 8)		
Appropriation from reserve		
Total		
DEDUCT. — Interest, rentals and other fixed charges (to be stated by each company in order of priority): £ s. d.		
Interest on Superannuation and other funds		
Rent charges (or feu duties) and Annuities		
Chief rents, wayleaves, etc., including lumpsum tolls		
Interest on loans		
Interest on debenture stocks (details)		
Rent of and guaranteed interest on leased and worked lines.		
Interest on Lloyd's Bonds.		
General interest		
Special items (if any)		
Total		
BALANCE AFTER PAYMENT OF FIXED CHARGES.		
Dividends on guaranteed and preference stocks: £ s. d.		
(Details)		
Total		
BALANCE AFTER PAYMENT OF PREFERENCE DIVIDENDS		
Appropriation to reserve and other special purposes: £ s. d.		
(Details)		
Total		
Balance available for dividends.		
Dividends on ordinary stock: £ s. d.		
(Details)		
Total		
Balance carried forward		

No. 9*a*. — Statement of interim dividends paid.

—	—	Year 19 .
	£ s. d.	£ s. d.
Balance available for dividends, year 19		
DEDUCT: £ s. d.		
Interim dividends paid (particulars)		
Undivided balance at 31 December, carried to balance sheet		

*

Year 19 .

Dr.

No. 10. — Receipts and expend

To expenditure.	—	Year 19 .	Percentag traffic receipt
			. . . . .
See abstracts.	£ s. d.	£	°/₀
A : Maintenance and renewal of way and works			
Maintenance and renewal of rolling stock : £ s. d.			
B (1) : Locomotives			
B (2) : Carriages			
B (3) : Wagons			
£ s. d.			
C : Locomotive running expenses			
D : Traffic expenses			
E : General charges			
Law charges			
Parliamentary expenses			
Compensation (accidents and losses) : £ s. d.			
Passengers			
Workmen			
Damage and loss of goods, property, etc.			
Rates and taxes			
Government duty			
G : Running powers (balance, debit or credit)			
Total traffic expenditure. . . . . £			
J : Joint lines (1).			
Miscellaneous			
Total expenditure . . . . . £			
Net receipts.			
Total . . . . . £			

Note. — Gross receipts to include the whole of the receipts from traffic carried over the company's lines, except wh
where (*b*) the payment made is by way of a fixed rent. The proportion of traffic receipts accruing to other compa
traffic receipts in this statement, but to be entered as a payment in the running powers account (abstract G). The pro
to be excluded from the traffic receipts in this statement, and entered as receipts in the running powers account.

(1) Under this heading should be entered only the expenditure or receipts of jointly owned and jointy leased lines in
companies (*see* abstract J). In the case of other joint lines, the company's proportion of the revenue and expenditur

Year 19 .

spect of railway working.

Cr.

By gross receipts.	—	—	Year 19 .	Percentage of traffic receipts.	
				. . . .	. . . .
ıbstracts.	£ s. d.	£ s. d.	£	%	%
SSENGER TRAIN TRAFFIC:					
Ordinary passengers:					
1st class					
2nd class					
3rd class					
Season-tickets:					
1st class					
2nd class					
3rd class					
Workmen's tickets					
Total receipts from passengers. . .					
Mails					
Parcels up to 2 cwt., parcels post, and Excess luggage . .					
Other merchandise by passenger trains					
Less expenses of collection and delivery. . .					
Total passenger train receipt. . .					
OODS TRAIN TRAFFIC:					
£ s. d.					
Merchandise					
Less expenses of collection and delivery . .					
Livestock					
Coal, coke, and patent fuel.					
Other minerals.					
Total goods train receipts					
Total traffic receipts . . . . . £					
MILEAGE, DEMURRAGE, AND WAGON HIRE.					
JOINT LINES (1)					
MISCELLANEOUS					
Total . . . . . £					

affic is carried over the company's line by trains of other companies and no annual payment is made therefor, or t of running powers exercised by them over the company's lines not to be treated as a deduction from the company's traffic receipts accruing to the company in respect of trains run by the company over the lines of other companies

ch the accounts are prepared by or for the joint committee and are not already embodied in those of the parent over the various heads on the respective sides of this account.

Year 19 .

Abstract A. — Maintenance of way and works.

—	—	—	Year 19 .
	£ s. d.	£ s. d.	£
Superintendence:			
Salaries			
Office expenses			
Maintenance of roads, bridges and works:			
Earthworks			
Bridges, tunnels, culverts, retaining walls, and other works			
Roads and fences			
Maintenance of permanent way:			
Renewal of running lines:			
Wages			
Materials			
Engine power and wagon repairs			
Repair of running lines and sidings:			
Wages			
Materials			
Engine power and wagon repairs			
Maintenance of signalling			
Maintenance of telegraphs			
Maintenance of stations and buildings:			
Stations, depots, and offices			
Engine sheds			
Carriage sheds			
Locomotive workshops			
Carriage workshops			
Wagon workshops			
Other buildings			
Total £			

Note. — When any sum is transferred to or from a depreciation fund or suspense account, the net sum to be stated.

Year 19 .

Abstract B. — Maintenance and renewal of rolling stock.

(1). — Locomotives.

— —	—	—	Year 19 .
	£ s. d.	£ s. d.	£
Superintendence :			
Salaries			
Office expenses			
Complete renewals :			
Wages			
Materials			
Repairs and partial renewals :			
Wages			
Materials			
Purchase of new locomotives			
Workshop expenses :			
Repairs and renewals of machinery and plant			
Other expenses			
Total £			

Note. — When any sum is transferred to or from a depreciation fund or suspense account, the net sum to be stated.

(2). — Carriages.

— —	—	—	Year 19 .
	£ s. d.	£ s. d.	£
Superintendence :			
Salaries			
Office expenses			
Complete renewals :			
Wages			
Materials			
Repairs and partial renewals :			
Wages			
Materials			
Purchase of new carriages			
Workshop expenses :			
Repairs and renewals of machinery and plant			
Other expenses			
Total £			

Note. — When any sum is transferred to or from a depreciation fund or suspense account, the net sum to be stated.]

(3). — Wagons.

— —	—	—	Year 19 .
	£ s. d.	£ s. d.	£
Superintendence :			
Salaries			
Office expenses			
Complete renewals :			
Wages			
Materials			
Repairs and partial renewals :			
Wages			
Materials			
Purchase of new wagons			
Workshop expenses :			
Repairs and renewals of machinery and plant			
Other expenses			
Total £			

Note. — When any sum is transferred to or from a depreciation fund or suspense account, the net sum to be stated.

Year 19

Abstract C. — Locomotive running expenses.

——	—	—	Year 19 .
	£ s. d.	£ s. d.	£
Superintendence :			
Salaries			
Office expenses			
Steam train working :			
Wages connected with the running of locomotive engines . .			
Fuel			
Water			
Lubricants			
Other stores, including clothing			
Miscellaneous			
Electric train working :			
Wages of motormen			
Electric current			
Lubricants			
Other stores, including clothing			
Total. . . . . £			

Note. — Any other form of power to be shown separately with corresponding details.

Year 19 .

Abstract D. — Traffic expenses.

—	—	—	Year 19
	£ s. d.	£ s. d.	£
Salaries and wages			
Superintendence			
Stationmasters and clerks			
Signalmen and Gatemen			
Ticket collectors, policemen, porters, &c.			
Guards			
Fuel, lighting, water, and general stores			
Clothing			
Printing, advertising, stationery, stamps and tickets			
Wagon covers, etc.			
Expenses of joint stations and junctions			
Cleansing, lubricating, and lighting of vehicles			
Shunting expenses (other than mechanical)			
Working of stationary engines, hoists, cranes, &c.			
Coal, &c., tipping expenses			
Railway clearing house expenses			
Miscellaneous expenses			
Total. £			

Abstract E. — General charges.

—	—	Year 19 .
	£ s. d.	£
Directors' fees voted by shareholders		
Fees paid to and expenses of directors on joint committee not included in abstract J.		
Auditors and public accountants (fees, clerkage and expenses)		
Salaries of secretary, general manager, accountant and clerks		
Office expenses, ditto		
Rating expenses		
Fire insurance		
Superannuation and benevolent funds, pensions, &c		
Subscriptions and donations (1)		
Miscellaneous expenses		
Total.		

(1) Amounts contributed to institutions not directly controlled by the company, and not for the exclusive benefit of the company's servants.

Abstract F. — Expenses of collection and delivery of parcels and goods.

—	—	Year 19 .
	£ s. d.	£
Salaries and wages		
Rent, rates, and taxes		
Maintenance of horses		
Maintenance of horse vehicles		
Maintenance of motors		
Amounts paid for hired cartage		
Miscellaneous		
Total.		
Amount charged to passenger train traffic.		
Amount charged to goods traffic		

Note. — The division of expenditure to be based as far as possible on actual figures.

Year 19 .

Abstract G. — Running powers.
Receipts and payments in respect of running power expenses.

—	Receipts (1).	Payments (2).	Balance.	Year 19. . . Receipts (1).	Year 19. . . Payments (2).	Year 19. . . Balance.
	£	£	£	£	£	£
Passenger train traffic . .						
Goods train traffic.						
Total. . .						

1 Receipts are the sums received by a company in respect of trains run by it over the lines of other companies.
2 Payments are the sums paid by a company in respect of trains run by other companies over its lines.

Abstract H. — Mileage, demurrage and wagon hire.

—	Receipts.	Expenditure.	Balance.	Year 19. . . Receipts.	Year 19. . . Expenditure.	Year 19. . . Balance.
	£ s. d.	£ s. d.	£ s. d.	£	£	£
Mileage and demurrage : Passenger train vehicles . Goods train vehicles. . .						
Hire of : Passenger train vehicles . Goods train vehicles . .						
Total. . .						

Abstract J. — Jointly owned and jointly leased lines.
Receipts and expenditure.

—	Name of joint line.	Name of joint line.	Name of joint line.	Total.	Year 19 . Total.
Gross receipts :	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£
(Details to follow Statement No. 10					
Total receipts					
Total receipts, company's proportion.					
Expenditure :					
(Details to follow Statement No. 10).					
Total expenditure.					
Total expenditure, company's proportion					

Note. — In this abstract should be entered only the receipts and expenditure of jointly owned and jointly leased lines in respect of which the accounts are prepared by or for the joint committee, and are not embodied under their respective headings in the accounts of the parent companies.

Year 19 .

No. 11. — Receipts and expenditure in respect of omnibuses and other passenger vehicles not running on the railway.

Dr. Cr.

To EXPENDITURE.	£ s. d.	Year 19 .	By GROSS RECEIPTS.	£ s. d.	Year 19 .
		£			£
Maintenance of horses . . .			Passengers		
— of horse vehicles			Hire of vehicles		
— of motors . . .			Miscellaneous		
— of buildings . .					
Traffic expenses					
Miscellaneous					
Total expenditure. . .					
Balance					
Total. . .			Total. . .		

Note. — When any sum is transferred to or from a depreciation fund or suspense account, the net sum to be stated.

No 12. — Receipts and expenditure in respect of refreshment rooms and cars where catering is carried on by the company.

Dr. Cr.

To EXPENDITURE.	£ s. d.	Year 19 .	By GROSS RECEIPTS.	£ s. d.	Year 19 .
		£			£
Salaries and wages			Total receipts.		
Provisions, wines and spirits consumed.					
Repairs and maintenance of refreshment rooms and of fittings, fourniture, etc., of refreshment cars					
Heating and lighting of refreshment rooms					
Miscellaneous					
Total expenditure. . .					
Balance					
Total. . .			Total. . .		

Note. — When any sum is transferred to or from a depreciation fund or suspense account, the net sum to be stated.

Year 19 .

No. 13. — Receipts and expenditure in respect of steamboats.

Dr. Cr.

To EXPENDITURE.	£ s. d.	Year 19 .	By GROSS RECEIPTS.	£ s. d.	Year 19 .
		£			£
Salaries and wages			Passengers		
Fuel			Parcels		
Stores, lubricants, water, etc.			Mails		
Repairs			Merchandise		
Harbour fees and light dues			Live Stock		
Miscellaneous			Miscellaneous		
Working expenses					
Insurance					
Total expenditure					
Balance					
Total			Total		

Note. — When any sum is transferred to or from a depreciation fund or suspense account, the net sum to be stated.

No. 14. — Receipts and expenditure in respect of canals.

Dr. Cr.

To EXPENDITURE.	£ s. d.	Year 19 .	By GROSS RECEIPTS.	£ s. d.	Year 19 .
		£			£
Superintendence			Tolls		
Wages of toll clerks, lock-keepers, etc.			Freight as carriers		
Maintenance of canal			Canal dock dues		
Water supply			Wharfage and cranage		
Auxiliary tramway expenses			Rents (net receipts)		
Traffic expenses as carriers			Miscellaneous		
Rates and taxes					
Miscellaneous					
Total expenditure					
Balance					
Total			Total		

Year 19 .

No. 15. — Receipts and expenditure in respect of docks, harbours and wharves.

Dr. Cr.

To expenditure.	£ s. d.	Year 19 .	By gross receipts.	£ s. d.	Year 19 .
		£			£
Superintendence			Harbour dues		
Maintenance			Light dues		
Dredging			Dock dues :		
Wages not included in above			On ships		
Rates and taxes			On goods		
Miscellaneous			On passengers		
			Wharf and pier dues		
Total expenditure			Cranage and other services		
			Graving docks		
Balance			Rents		
			Miscellaneous		
Total			Total		

Note. — When any sum is transferred to or from a depreciation fund or suspense account, the net sum to be stated.

No. 16. — Receipts and expenditure in respect of hotels.

Dr. Cr.

To expenditure.	£ s. d.	Year 19 .	By gross receipts.	£ s. d.	Year 19 .
		£			£
Salaries and wages			Total receipts		
Provisions, wines and spirits consumed					
Repairs and maintenance (1)					
Heating and lighting					
Rents					
Rates and taxes					
Miscellaneous					
Total expenditure					
Balance					
Total			Total		

Note. — When any sum is transferred to or from a depreciation fund or suspense account, the net sum to be stated.

(1) To include expenditure on buildings, furniture and plant.

No. 17. — Receipts and expenditure in respect of other separate businesses carried on by the company.

[No forms suggested.]

Year 19 .

No. 18. — Electric power and light account.

— —	—	—	Year 19 .	— —	—	—	Year 19 .
	£ s. d.	£ s. d.	£		Number of units.	£ s. d.	Number of units. £
Superintendence :							
Salaries							
Office expenses . .				Current supplied :			
				For traction. . . .			
Total superintendence.				For power			
				For lighting, . . .			
Generation :				To other consumers.			
Maintenance of buildings							
Maintenance of plant, machinery, and tools							
Maintenance of feeders, cables and accessories . . .							
Salaries and wages .							
Fuel, including carriage, etc.. . . .							
Oil, waste, water, and stores							
Special items . . .							
Total generation. .							
Distribution :							
Maintenance of feeders, mains, and apparatus. . . .							
Maintenance of meters, switches, fuses, lamps, etc.							
Salaries and wages .							
Royalties, etc., payable for use of patents . .							
Rents payable . . .							
Rates and taxes . . .							
Special charges :							
(To be enumerated) .							
£				Total. . .			

Note. — When any sum is transferred to or from a depreciation fund or suspense account, the net sum to be stated.

Year 19 .

No. 19. — General balance sheet.

Dr. Cr.

—	—	Year 19 .	—	—	Year 19 .
	£ s. d.	£		£ s. d.	£
To capital account, balance at credit thereof, as per account No. 4.			By capital account, balance at debit thereof as per account No. 4		
Amount due to bankers . . .					
Temporary loans and calls paid in advance.			£ s. d.		
Lloyd's Bonds			Cash at bankers and in hand		
Unpaid interest and dividends .			Cash on deposit at interest		
Interest and dividends payable or accruing and provided for.					
Amount due to railways companies and committees . . .			Investments in consols and government securities . .		
Amount due to railway clearing houses			Investments in stocks and shares held by the Company not charged as capital expenditure		
Savings bank					
Superannuation and other provident funds			Investment of superannuation and other provident funds .		
Accounts payable			Stock of stores and materials .		
Liabilities accrued.			Outstanding traffic accounts .		
Miscellaneous accounts . . .			Amount due by railway companies and committees . .		
Special items (to be detailed) .			Amount due by railway clearing houses		
Fire insurance fund			Amount due by postmaster-general		
Depreciation funds :			Accounts receivable		
Railway			Miscellaneous accounts. . .		
Steamboats (including insurance fund)			Suspense accounts (if any) to be enumerated		
Other businesses			Special items (to be detailed) .		
General reserve fund					
£ s. d.					
Balance available for dividends and reserve as per account No. 9. .					
Less interim dividends paid as per statement No. 9a.					

PART II. — STATISTICAL RETURNS.

Year 19 .

I. — Mileage of lines.

A. — Mileage of lines open for traffic.

— —	Running lines. Length of road. First track.	Second track.	Third track.	Fourth track.	Over four tracks (reduced to single track).	Total miles reduced to single track.	Sidings reduced to single track.	Total of single track, including sidings.	Year 19 . *Total of single track including sidings.*
	M. Ch.	M. Ch.	M. Ch.	M. Ch.	M. Ch.	M. Ch.	M. Ch.	M. Ch.	M. Ch.
LINES OWNED BY COMPANY: Main and principal lines: (Details). . . .									
Total of main and principal lines									
Minor and branch lines (summarised by districts): (Details) . . .									
Total. . .									
LINES JOINTLY OWNED (COMPANY'S SHARE OF OWNERSHIP): As enumerated in abstract J: (Details). . . .									
Total. . .									
Other joint lines.									
Total lines jointly owned									
Total miles of lines owned and company's share of lines jointly owned . .									
Ditto, ditto year 19 .									
LINES LEASED OR WORKED: By the company: (Details). . . .									
Total. .									
Jointly with other companies (company's share): As enumerated in abstract J: (Details) . . .									
Total. . .									
Other jointly leased or worked lines.									
Total miles of lines leased or worked and company's share of lines jointly leased or worked . . .									
GRAND TOTAL. . .									
Ditto, ditto year 19 .									

Year 19 .

B. — Mileage of lines authorised but not open for traffic.

—	Miles authorised.	Miles constructed and not open for traffic.		Miles under construction.	Miles not commenced, or in abeyance.
	Length of road.	Length of road.	Length (including sidings) reduced to single track.	Length of road.	Length of road.
	M. Ch.	M. Ch.	M. Ch.	M. Ch.	M. Ch.
LINES OWNED BY THE COMPANY:					
New lines;					
(Details)					
Total. .					
Ditto, year 19 . .					
Widenings and additions;					
(Details)					
Total. . .					
Ditto, year 19 . . .					
JOINT LINES (COMPANY'S SHARE OF OWNERSHIP):					
New lines					
Ditto year 19 . . .					
Widenings additions. . .					
Ditto year 19 . . .					

C. — Mileage of lines run over by the company's engines.

—	M. Ch.	*Year 19* . M. Ch.
Lines owned by the company		
" partly owned		
" leased, or worked by the company		
" leased, or worked jointly		
" over which the company exercises running powers.		
Total. . .		

Year 19 .

II. — Rolling stock.

A. — Steam locomotives and tenders.

——	—	*Year 19* .
Description.	Number.	*Number.*
Tender engines : (Wheel types to be stated).		
Tank engines : (Wheel types to be stated).		
Tenders		

B. — Rail motor vehicles.

——	—	—	*Year 19* .	
——	Number.	Carrying capacity	*Number.*	*Carrying capacity.*
Steam power.		Seats.		*Seats.*
Petrol power.				
Other power (self-contained)				
Total. . .				

C. — Trains worked by electric power.

——	—	—	*Year 19* .	
——	Number.	Number.	*Number.*	*Carrying capacity.*
Details to be filled in, as instructed by the Board of Trade from time to time, by individual companies with regard to the various systems in use		Seats.		*Seats.*

Year 19 .

D. — Coaching vehicles (other than electric).

—	Number.	Seats or berths.				Year 19 .	
		1st class.	2nd class.	3rd class.	Total.	*Number.*	*Seats or Berths, Total.*
PASSENGER CARRIAGES.							
Carriages of uniform class .							
Composite carriages . . .							
Restaurant cars.							
Miscellaneous							
Total . .							
Sleeping cars.							
Total passenger carriages.							
OTHER COACHING VEHICLES.							
Post office vans.							
Luggage, parcel and brake vans.							
Carriage trucks.							
Horse boxes							
Miscellaneous							
Total other coaching vehicles							
Total coaching vehicles.							

E. — Merchandise and mineral vehicles.

—	—	Year 19 .
	Number.	*Number.*
Open wagons:		
Under 8 tons.		
8 and up to 12 tons		
Over 12 and up to 20 tons.		
Over 20 tons (other than special)		
Covered wagons:		
Under 8 tons		
8 and up to 12 tons		
Over 12 and up to 20 tons.		
Over 20 tons		
Mineral wagons (to be shown by companies owning separate mineral stock):		
Under 8 tons.		
8 and up to 12 tons		
Over 12 and up to 20 tons.		
Over 20 tons		
Special wagons (for loads of exceptional dimensions and weight)		
Cattle trucks		
Rail and timber trucks (including twin trucks)		
Brake vans		
Miscellaneous		
Total. . .		

Year 19 .

F. — Railway service vehicles, and horses for shunting.

—	Number.	*Year 19 .* *Number.*
Gasholder trucks		
Locomotive coal wagons		
Ballast wagons		
Mess and tool vans		
Breakdown cranes		
Travelling cranes		
Miscellaneous		
Total		
Horses for shunting		

III. — Horses and road vehicles employed in the collection and delivery of parcels, goods, and passengers.

—	Number.	*Year 19 .* *Number.*
GOODS AND PARCELS ROAD VEHICLES :		
Road motors for goods and parcels		
Horse wagons and carts		
Miscellaneous		
Total		
PASSENGER ROAD VEHICLES :		
Road motors		
Tramcars		
Omnibuses		
Cabs		
Miscellaneous		
Total		
HORSES FOR ROAD VEHICLES		

Year 19 .

IV. — Steamboats.

—	Date of construction.	Indicated Horse-Power.	Registered tonnage.
Steamboats over 250 tons net . . . . . (Name of each to be given).			Tons.
Total. .	Number.		
Do. Year 19...			
	Number.	Total horse-power.	Total registered tonnage.
Steamboats of 250 tons net and under			
Grand total. . .			
Do. Year 19...			

V. — Canals.

Name.	Length in miles.
Total Length. . .	

VI. — Docks, Harbours and wharves.

Name.	Length of quay.

VII. — Hotels.

Name.	Situation.

Year 19 .

VIII. — Land, property, etc., not forming part of the railway or stations.

Land.	Acreage.	*Year 19 .* *Acreage.*
Agricultural land		
Urban and suburban land		

Houses.	Number.	*Year 19 .* *Number.*
Labouring class dwellings		
Houses and cottages for companies' servants		
Other houses and cottages.		

IX. — Other industries (if any).

(No form suggested.)

X. — Maintenance and renewal of way and works (abstract A).

—	—	*Year 19...*
Quantities of principal materials used :		
Ballast	Yards.	*Yards.*
Fencing	Miles.	*Miles.*
Rails	Tons.	*Tons.*
Sleepers	No.	*No.*
Miles maintained :		
Miles of road	No.	*No.*
Miles of road reduced to single track :		
a) Running Lines	No.	*No.*
b) Sidings.	No.	*No.*
Miles of track renewed	No.	*No.*

Year 19 .

XI. — Maintenance and renewal of rolling stock (abstract B).

	In Company's Workshops.	By Contract.	Total.	*Year 19...* *Total.*
Locomotives Renewed. . . . . Number				
— Repaired :				
Heavy Repairs. . . . —				
Light — . . . . —				
— Under or awaiting Repair at end of Year (1) . . . . . -				
Rail Motor and Electric				
Train Vehicles, etc., Renewed . . . —				
— — Repaired . . . —				
Heavy Repairs				
Light — —				
— — Under or awaiting Repair at end of Year (1) .				
Coaching Vehicles :				
a) Carriages Renewed . . . . . —				
— Repaired :				
Heavy Repairs . . .				
Light — . . .				
— Under or awaiting Repair at end of Year (1) . . . . . —				
b) Others Renewed . . . . . -				
— Repaired :				
Heavy Repairs				
Light — . . . . —				
— Under or awaiting Repair at end of Year (1)				
Wagons Renewed . . . . . —				
— Repaired :				
Heavy Repairs. . . . . -				
Light — . . . . . -				
— Under or awaiting Repair at end of Year (1). . . . . —				

(1) Total only to be shown.

XII. — Engine mileage.

		Train miles. (Loaded trains.)			Train miles. (Including empty trains run for traffic purposes on either the forward or return journey.)			Shunting miles.		Other miles. (Assisting, light, etc.	Total Engine miles.	Year 19...									
												Train miles. (Loaded trains.)			*Train miles. (Including empty trains run for traffic purposes on either the forward or return journey.)*			*Shunting miles.*		*Other miles. (Assisting, light, etc.)*	*Total Engine miles.*
		Coaching.	Goods.	Total.	Coaching.	Goods.	Total.	Coaching.	Goods.			*Coaching.*	*Goods.*	*Total.*	*Coaching.*	*Goods.*	*Total.*	*Coaching.*	*Goods.*		
A	Miles run in relation to the company's traffic receipts :																				
	Over the company's system by the company's engines (1)																				
	Over the company's system by other companies' engines (2)																				
	Add company's proportion (according to ownership) of miles run on joint account over joint lines not included in abstract J.																				
	Total. . .																				
B	Miles run in relation to the company's expenditure :																				
	By the company's engines over lines owned, leased, or worked by the company.																				
	By the company's engines over other companies' lines																				
	Add company's proportion (according to ownership) of miles run on joint account over joint lines not included in abstract J.																				
	Total. . .																				
C	Miles run by the company's engines :																				
	Over lines owned, leased, or worked by the company																				
	Over all joint lines																				
	Over other companies' lines																				
	Total. . .																				

(1) To include miles run by the company's engines over joint lines or other companies' lines in cases where no toll is paid or where the payment made is not based upon a proportion of the gross receipts.

(2) To exclude miles run by such companies in cases where no toll is received and where the payment received for the use of the line is not based upon a proportion of the gross receipts.

NOTE. — Miles run by (1) steam tender and tank engines, (2) electric traction, (3) steam, petrol, etc., rail motors to be given in a supplementary statement as regards the various heads in C.

Year 19 .

XIII. — Passenger traffic and receipts.

Class of passenger.	Number.	Receipts.	Average fare per passenger.	Number originating on the company's system.	Year 19 .			
					Number.	*Receipts.*	*Average fare per passenger.*	*Number originating on the company's system.*
Ordinary :		£	*d.*			£	*d.*	
1st class								
2nd " . . .								
3rd "								
Workmen (1) . . .								
Total. . .								
Season : (2)								
1st class . . .								
2nd "								
3rd "								

(1) To be calculated on a single journey basis. (2) To be calculated on an annual basis.
Note. — Receipts in column 2 to be the receipts from passengers as given in account No. 10; the number of passengers in column 1 to be the number corresponding thereto.

XIV. — Goods traffic and receipts.

—	Tonnage.	Receipts.	Average receipt per ton.	Tonnage originating on the company's system.	Year 19 .			
					Tonnage.	*Receipts.*	*Average receipt per ton.*	*Tonnage originating on the company's system.*
	Tons.	£	*d.*	Tons.	*Tons.*	£	*d.*	*Tons.*
Merchandise . . .								
Coal, coke and patent fuel								
Other minerals . .								
Total. . .								
	Number.		—	Number originating on the company's system.	*Number.*		—	*Number originating on the company's system.*
Live stock								

Note. — Receipts in column 2 to be the goods train receipts as given in account No. 10; the tonnage in column 1 to be the tonnage corresponding thereto.

Year 19 .

XV*a*. — Tonnage of the principal classes of minerals and merchandise carried by goods trains.

[The tonnage of the principal articles of traffic originating or terminating on each railway company's system, and carried in consignments of not less than two tons, to be separately stated.]

XV*b*. — Number of live stock carried by goods trains.

——	Number.	*Year 19 .*
		Number.
Horses.		
Cattle		
Calves.		
Sheep		
Pigs		
Miscellaneous		
Total. . .		

XVI. — Summary of financial results secured in comparison with those for past years.

Note. — Not to be made retrospective, but to be extended year by year until ten years are given.

——	19 .	19 .	19 .	19 .
	£	£	£	£
Total expenditure on capital account (No. 4)				
Gross receipts from businesses carried on by the company (No. 8)				
Revenue expenditure on ditto (No. 8).				
Net receipts of ditto. (No. 8)				
Miscellaneous receipts net (No. 8)				
Total net income (No. 8)				
Interest, rentals, and other fixed charges (No. 9)				
Dividends on guaranteed and preference stocks (No. 9). . .				
Balance after payment of preference dividends (No. 9) . , .				
Dividend on ordinary stock (No. 9).				
Rate per cent	°/₀	°/₀	°/₀	°/₀
Surplus or deficit.				
Appropriation to or from reserve				
Brought forward from previous years.				
Carried forward to subsequent years				

(Signed) . . . . . *Accountant of the company.*

Year 19 .

Certificates of the responsible officers as to the upkeep of the whole of the company's property.

(Signed for the board of directors) { ——————*chairman or deputy chairman of the company.*
——————*secretary of the company.*

Auditor's certificate.

As prescribed by act 30 & 31 Victoria, cap. 127, to follow, substituting yearly for half-yearly accounts.

Index.

Map.

Note. — This should be explanatory of the railway system.

APPENDIX II.

Schedule to the reservation,

By Messrs. ACWORTH, PAISH and PEEL.

Year 19 .

XIII. — Engine hours

— .	Train (including assisting and light).	Shunting.	Total.	*Year 19* .		
				Train (including assisting and light).	*Shunting.*	*Total.*
Passenger						
Goods.						
Mineral						

XIV. — Carriage mileage.

Miles run by :	—	*Year 19* .
Passenger coaches.		
Other vehicles on passenger trains		
Total mileage of coaching vehicles. . .		

Year 19 .

XV. — Wagon mileage.

—	Loaded.	Empty.	Total.	Year 19 .		
				Loaded.	*Empty.*	*Total.*
	Miles.	Miles.	Miles.	*Miles.*	*Miles.*	*Miles.*
Merchandise, &c.						
Minerals						
Total. . .						

XVI. — Passenger mileage.

To replace XIII in the schedule of the report.

Class of passenger.	Number conveyed.	Passenger mileage.	Average distance conveyed.	Receipts.	Average receipt per passenger per mile.	Year 19 .				
						Number conveyed.	*Passenger mileage.*	*Average distance conveyed.*	*Receipts.*	*Average receipt per passenger per mile.*
	No.		Miles.	£	*d.*	*No.*		*Miles.*	£	*d*
1st class.										
2nd —										
3rd —										
Total. . .										

XVII. — Ton mileage.

To replace XIV in the schedule of the report.

Class of tonnage.	Tons conveyed.	Ton mileage.	Average distance conveyed.	Receipts.	Average receipt per ton per mile.	Year 19 .				
						Tons conveyed.	*Ton mileage.*	*Average distance conveyed.*	*Receipts.*	*Average receipt per ton per mile.*
			Miles.	£	*d.*			*Miles.*	£	*d.*
Merchandise, etc. .										
Minerals										
Total . .										

Year 19 .

XVIII. — Passenger train and carriage loads.

		Year 19 .
Number of coaches per train mile :		
Passenger		
Other vehicles		
Total.		
Number of passengers per passenger train mile :		
1st class		
2nd —		
3rd —		
All classes		
Receipts per passenger train mile :		
1st class		
2nd —		
3rd —		
Other passenger train receipts		
Total.		
Number of passengers per carriage mile :		
All classes		
Receipts per passenger vehicle mile :		
Passenger coach		
Other vehicle		
Total.		
Number of train miles per passenger engine hour		

XIX. — Goods train and wagon loads.

	Merchandise, etc.	Minerals.	Total.	Year 19 . Merchandise, etc.	Minerals.	Total.
Wagon per train mile :						
Loaded No.						
Empty No.						
Total. No.						
Average train load (ton miles per train mile, revenue tons only) Tons.						
Average wagon load (ton miles per wagon mile, revenue only) :						
Per loaded wagon mile Tons.						
Per wagon mile (loaded and empty) Tons.						
Train miles per engine hour. No.						
Wagon miles per engine hour No.						
Receipts :						
Per train mile (loaded and empty) *d.*						
Per wagon mile (loaded and empty) *d.*						

Year 19 .

XX. — Density of traffic

—	Per mile of road.	Per mile of track.	*Year 19* .	
			Per mile of road.	*Per mile of track.*
Passenger miles :				
1st class.				
2nd —				
3rd —				
Total. . .				
Ton miles :				
Merchandise, &c.				
Minerals				
Total. . .				

XV*a*. In the schedule of the report becomes XXI*a*.
XV*b*. — — — XXI*b*.
XVI. — — — XXII.

[313 .385. (01]

REPORT N° 3

(all countries except Great Britain, British colonies and America)

By Mr. BARRIOL,
CHIEF OF DIVISION, PARIS-LYONS-MEDITERRANEAN RAILWAY.

SUMMARY.

I. — *Introduction.*
II. — *Principles of statistics of railways in operation.*
A. — General observations.
B. — Statistics of cost of establishment, financial resources, charges.
a) Installation of lines;
b) Rolling-stock;
c) Tools and appliances;
d) Stores;
e) Financial resources;
f) Charges
C. — Statistics of revenue :
a) Revenue in general;
b) Grande vitesse receipts :
Passengers;
Luggage, dogs, etc.;
Grande vitesse goods.
c) Petite vitesse receipts;
d) Miscellaneous receipts;
e) Statistics of revenue per station and line.
D. — Statistics of expenditure.
E. — Various statistics.
F. — General statistics.
III. — *Uniform classification of working expenses.*
A. — General remarks.
B. — Expenses. — Central administration.
C. — Working expenditure properly so called. — Internal and general traffic.
D. — Expenses of locomotives and rolling stock.
E. — Expenses of maintenance of way and works.
F. — Miscellaneous expenses.
IV. — *Conclusions.*

I. — Introduction.

The report upon this question, entrusted originally to the late Mr. Hodeige, inspector-general of the management of the Belgian State Railway, was placed, after the decease of the latter gentleman, in the hands of the Hon. Mr. De Geynst, inspector of management of the same railway. Reasons of health have prevented our colleague from pursuing the work, which has thus devolved upon us under somewhat difficult circumstances, and it is rather as a substitute, than as the responsible reporter, that we have completed the present study.

Mr. Hodeige had drawn up a detailed list of questions with the view of eliciting the information necessary for the adequate treatment of the subject confided to his care. We reproduce this list of questions as an annex, with the explanatory note which accompanied it (appendix 1).

It is divided into four parts :

1° System of classification of working expenses ;
2° Particulars of lines in operation ; length, gradients, curves, stations and yards ;
3° Particulars of rolling-stock ;
4° General results of the working ; revenue, expenditure, traffic, mileage run.

This division does not correspond exactly with the wording of the question as it was framed by the Permanent Commission of the Congress.

It would have been better, perhaps, to have observed the order indicated in that wording, which would have led to the completion of the list of questions by a request for information regarding establishment expenses, the net cost of the lines, the resources which served to effect the construction, details of the traffic, and a complete analysis of the various matters relating to revenue and working expenses. The reporter would thereby have been enabled to formulate interesting comparisons between the various documents communicated by the administrations.

Lacking the necessary elementa, and pressed for time, we have been obliged to confine ourselves, as far as possible, within the general limits laid down by Mr. Hodeige, and to renounce, to our great regret, the idea of giving to the subject all the amplitude it deserved.

The railways which responded to the appeal of Mr. Hodeige number forty-five, and a list of them is given, with a comment upon the replies, in annex II. We can only regret the brevity of certain of the answers, which simply refer to administrative documents not containing the information desired.

However, despite the limited time left at our disposal, it has appeared to us impossible merely to reproduce the replies of the administrations.

We have endeavoured, therefore, dealing with the question as it was put, to

evolve from the documents received the essential bases of the statistics which it would be desirable to see established by all railway administrations, together with a uniform classification of the working expenses, which might have been discussed.

In our opinion, studies of this kind can only bear fruit if they consider details; for the headings of accounts or statistics being necessarily very general, with a view to being short, one finds, sometimes, very diverse elements in accounts of a similar character kept by railway administrations of one and the same country, and, *a fortiori* by administrations of different nationalities.

II. — Principles of statistics of railways in operation.

A. — General observations.

Whatever the organized financial methods of railways may be, and whether the latter belong to private companies or are operated by the State, the principal object of the administration should be the avoidance of a deficit which, in the former case, is prejudicial to the shareholders, and in the latter burdens the tax-payers, some of whom would be injured to the advantage of those who utilized the means of traffic to a preponderating extent.

It is necessary, then, to seek to maintain in equilibrium the receipts and expenses, adding thereto, if required, the charges for interest and amortization and the various company charges.

In order to effect this equilibrium, it is requisite to study the results arrived at during the preceding financial years, that is to say to keep perpetually in view statistics of all the elements of revenue and expenditure. A great number of these elements result from the classification of the various operations of revenue and expenditure by the accountants' department, which enters them directly in special accounts; but, apart from these statistical elements, which are purely matters of book-keeping, it is necessary to establish others by means of returns specially designed to enable forecasts to be made of the future of the undertaking. We shall be careful to mark, as far as possible, the distinction between these two very different categories of statistics, the first of which is almost inevitably rigorous in character, whilst the second, more or less exact, depends entirely upon the executive agents and the supervision exercised over them.

In any scheme of railway statistics it is necessary to admit at once three groups : *Revenue, expenditure*, and *charges*. From the strictly-logical point of view, it is preferable to study, in the first instance, the statistics relating to charges, for these result from resources corresponding to the establishment expenses of the lines, that is to say from the very origin of the railway.

But, independently of these groups of statistics, there exist a great number of auxiliary statistics, relating either to the traffic itself or to exterior matters, which are of not less considerable importance than those indicated, and which facilitate the determination of the coefficients, the ratios, utilized in comparing different railway systems.

To sum up, railway statistics may be grouped as follows :

Statistics of cost of establishment, financial resources, charges;
Statistics of revenue;
Statistics of expenditure;
Miscellaneous statistics.

B. — STATISTICS OF COST OF ESTABLISHMENT, FINANCIAL RESOURCES, CHARGES.

a) *Installation of lines.* — Mr. Hodeige has indicated with perfect accuracy in his list of questions the various statistics requisite to enable a distinction to be drawn between the lines, according to their dates of concession and opening, the time employed in their construction, and their length, a separation naturally being made between single, double and multiple lines, and account being taken of the gauge.

Returns of a very simple character ought to suffice to show the length of the rails according to their composition (steel, iron) and cross-section, as well as the nature of the track, both as regards the sleepers (iron, oak, soft wood, creosoted or otherwise) and the ballast employed, with the quantity of these materials.

The return of the numbers of stations, yards, stopping places, level crossings, overbridges and underbridges, bridges according to their span, their height, etc., gives results which should be completed by a statement of the unit prices.

These it is unfortunately very difficult to find in the majority of cases from the replies addressed to us.

As a matter of fact, the administrations content themselves generally, with dividing up the establishment expenses under certain headings and sections which differ greatly according to the particular administration.

We gladly recommend the following division :

I. — General expenses, including general costs of management, of central administration, etc.
II. — Purchase of lands, expropriations, law expenses, etc.
III. — Earthwork, constructional works.
IV. — Permanent way and ballast (materials).
V. — Station buildings, workshops, stores, depots, telegraphic installations, etc.

These statistics of expenditure are drawn from the accounts, but their value must not be exaggerated, for in attempting to unify the establishment records of two constructive services attached to the same railway, and in going into the details of the items, we have discovered notable differences of interpretation.

Other distinctions can be made, and will give rise to interesting statistics and comparisons, if, the systems being the result of concessions, the State becomes a party to the expenditure, whether by guaranteeing a certain proportion of the latter, by granting subsidies, or by having the various construction works executed by its engineers or by those of the Companies.

We must distinguish, equally, the buying-up of lines, transfers, amalgamations, etc.

b) *Rolling-stock.* — Statistics as to rolling-stock relate to the nature and cost of the vehicles.

Locomotives will be included in accordance with their type, power, number of driving and carrying axles, and their use on the road; they will be distinguished according to whether they are coupled or not to the tenders, etc., and, finally, their unit price will be determined and their cost per kilogram of material.

Passenger carriages will be divided up into types or classes, in accordance with the number of seats available, the number of carrying axles, the bogies, the kind of lighting and heating, and the unit price. Similarly, the goods wagons, the vans, will be classified as covered or open : special trucks for heavy materials, etc., care being taken to note the ordinary load, and the unit price.

c) *Tools and appliances.* — The tools and appliances alike of the constructive services and the workshops and depots are made the object of detailed inventories, as in the case of rolling-stock. The statistics are therefore very easy to keep, and the quantities and unit prices will be easily determined.

d) *Stores.* — We will add to the cost of establishment the stores, although nearly one-third, at least, of the value of the materials supplied might be considered as probable working expenditure.

They are the object of detailed inventories which permit of the classification of the plant, fuel, road material, rails, sleepers, etc., according to their kind and price. Unfortunately the detailed statistics are rarely published, and it is rather difficult to discover points of comparison between the systems.

e) *Financial resources.* — The financial statistics are very simple. It suffices to distinguish the origin of the resources and the nature of the loans, in any.

The classification of subsidies of the State, of communes, and of private persons, paid in capital, in kind, in short or long annuities, and of the resources derived from subscriptions in shares or bonds, will effect itself, thanks to the ordinary process of bookkeeping.

But it will be necessary to keep special statistics in order to ascertain the cost of the printing of the share certificates, the expenses of issue brokerage, cost of negociation, service expenses, etc., and although accounts may be of great assistance in these

determinations, there cannot fail to be a good deal of arbitrariness in the estimate of such special expenses, often difficult to localize.

Statistics of this kind make it possible to follow the variations in the rate of issue, and to appreciate by comparison the credit enjoyed by the respective railway systems; but the calculations necessary to this end are much less simple than is usually believed.

Let us call to mind the statistics relative to the circulation of the securities, whether to bearer, or inscribed; to their distribution among the public, to the importance of the small notes or coupons, etc.

f) *Charges.* — Charges may be divided up into interest, redemptions and accessory expenses. The rate of issue of the securities, their nominal capital value, their period of redemption, and the method of such redemption (annuities fixed, variable) determine the proportions of the three special species of charges, and render it easy to establish statistics which are purely matters of accounts and therefore rigorously exact.

The attribution of these charges in levies upon the proceeds of the working may form the object of statistics of a wholly special character, notably in France, but in view of their character it is not convenient to insist upon these.

C. — Statistics of revenue.

a) *Revenue in general.* — The revenue develops in two ways (assuming properly-established tariffs), either by an augmentation of traffic upon the lines already existing, or by an increase in the length of the system. Statistics reveal the first mode of variation, and facilitate the establishment of the probable result of the second.

The traffic being made up of very varied elements, the statistics relating to the elements of revenue are very complex.

In general, distinction is drawn between two great categories of revenue in the shape of *grande vitesse* (passenger and parcels) and *petite vitesse* (goods) traffic; but some systems add to these a third category of accessory receipts which are not traffic receipts properly so called (1).

This classification, created somewhat artifically at the period of the origin of railways, is rational enough; it divides the traffic receipts into two parts which, if not equal, are at any rate, sufficiently nearly so.

In general, it will be necessary to make daily returns of revenue received in order to establish comparisons with the preceding financial years. There is scarcely need to say that such comparisons will only be of utility as regards anticipations of the

(1) Certain systems adopt a classification of revenue according to the nature of the traffic : passengers, goods, various.

future if account is taken of variations due to holidays, to the 29th day of February, to political events, etc., but this process as regards any general collection of statistics of the kind is evidently indispensable, and is the first point which occurs to one's mind.

It is necessary, finally, to mention the differences which exist between the methods of bookkeeping of the various railway administrations, some of which make a return of receipts actually cashed, and others of receipts for which a written order has been given, but the cashing of which will be effected later on. The latter mode of procedure should be the rule for Companies with a limited concession.

b) " *Grande vitesse* " *receipts.* — *Grande vitesse* receipts are divided into varying categories, according to the system and the country : passengers, luggage, dogs, cash, postal packets, horses, cattle, warehousing, parcels.

All the receipts, authenticated by actual cash collections, are easily localized, but it is necessary to discriminate between them further with a view to obtaining information as to price, kind, weight, and if possible bulk.

Passengers.

Passengers will be distinguished by class and by character of trains, if there is an extra charge for express trains. Enumeration will be made of the number of tickets issued by the stations for this or that destination; of passenger-tickets at full fares, at $^1/_2$, $^1/_4$ at $^1/_{10}$ fares; return-tickets; season tickets; tickets for routes according to section, district, canton, department, system, country; tickets for excursions, society gatherings, pilgraimages, congresses, etc.; combined circular tickets, emigrant tickets, military traffic, penitentiary traffic, etc.

The effective recording of these elements will enable one ultimately to forecast, almost exactly, the probable revenue under given circumstances, to determine approximately the probable passenger receipts of a new line, etc.

The passenger statistics will be of service in ascertaining the alterations of class, the mean distance travelled, the reason of these variations and the effects upon the ultimate proceeds of the working.

The checking-off, approximate otherwise, of the total mileages of passengers, assists in the determination of the average fares and of the average mileage, which afford an approximate estimate of the yield of a new line, or of a shortened route. It would not, of course, be advisable to apply the figures thus obtained to anticipations with regard to new countries.

Let us confine ourselves to recording the fact that some railway systems record the averages of passengers per track-kilometre, per locomotive-kilometre, per train-kilometre, or even per axle-kilometre.

Luggage, dogs, etc.

As regards luggage, dogs, the transport of cash, details of weight, bulk and value might usefully be recorded.

The conveyance of postal packets and parcels should be the object of detailed statistics, with the view of developing a very special class of traffic between one country and another, or even between two points of the same country, notably the traffic in early produce, fruits, flowers, etc.

Finally, as regards the conveyance of carriages, horses, cattle, statistics will show clearly the conditions of development of certain industries (carriage-building, motor cars, etc.) and of the breeding of stock; it will raise questions of amelioration of tariff, or methods and conditions of transport.

" Grande vitesse " goods.

Grande vitesse goods belong to very special categories, being either perishables, or fancy goods the cost of conveyance of which is only a negligeable addition to the price of the material: it is obviously necessary to establish distinctions between each class of goods in order to be able to either modify the tariffs, or ameliorate the conditions of transport as regards wagon accommodation (refrigerator van, baskets, packing, etc.).

c) " *Petite vitesse* " *receipts.* — The *petite vitesse* groups include, for the most part, goods and animal traffic, but not in so great a quantity as in the case of the *grande vitesse.*

The differentiation of goods can be carried out to the fullest extent. It is impossible to be too exacting on this subject, and statistics will render great service in the establishment of tariffs applicable to new materials which industry may have created, or which, extracted from the earth, may have come into common use. Such new materials can be classified by analogy as regards utility, employment, etc.

But the interest in this information would be even greater at the period of the establishment of a new line, or when shortening a line already established, in that they would enable a forecast to be made of the development of the traffic, or the effect of the partial withdrawal, which might have very serious consequences for private companies, bound to the State by special conventions.

As in the case of passengers, an approximate return ought to be made of the mileage of each ton carried.

The problem is complex, for the bulk of the various goods differs in very considerable proportions.

By comparing the number of ton-kilometres of the goods (that is to say Σtp, t representing the weight of the goods and p the distance they are carried, with the number of train-kilometres or the number of carriage-kilometres, one obtains sta-

tistical ratios all the more interesting because the systematic errors which result from the establishment of numerical data remain practically constant, so that the coefficients remain comparable as between one year and another. Such are : the average load of a goods train and of a goods wagon; these are characteristic of the good or bad utilization of the stock and consequently of the good or bad working.

In the case of goods, statistics should be kept of the usage of the wagons according to their kind, with a view to a proper account being rendered of the utilization of stock. Furthermore, such statistics furnish a very important index to the value of the probable revenue in taking account of the wagons standing still, or circulating outside the system. This estimate, quite approximate of course, facilitates the verification of the indications of revenue resulting from the paying-in of the stations.

Finally, the analysis of goods traffic by tariffs, according to whether they are normal, exceptional, combined, whether they belong to unions, or to special tariffs from country to country, gives rise to statistical enumerations of considerable importance, although few systems have been willing to go to the expense necessary to carry out this rather delicate task properly.

Certain companies charge to the *petite vitesse* receipts the service traffic, that is to say, the traffic which they effect on their own account or on that of the State, if they provide for it. In general, the traffic carried in this way is rated at very low contract rates, which falsify to a certain extent the working receipts. It is hardly necessary to exaggerate the error which is thus committed, for the service freights represent scarcely 2·5 per cent of the amount of the total receipts, and the lessening of revenue is certainly under 0·4 per cent of this total. It has for counterpart a diminution of the establishment or working expenses.

Let us simply remark that the charging to revenue of the service freights, a system of which we are personally a convinced partisan, has the effect of somewhat augmenting the working coefficient which would have been obtained if one had placed them to the credit of expenditure.

d) *Miscellaneous receipts.* — This group of receipts does not exist in the case of all the companies. It nevertheless appears rational enough, for it permits of a clear distinction being drawn between the traffic receipts, and the non-traffic receipts inherent in the very existence of the railway : proceeds of estates, lands not utilized, stations held in common with other companies, letting of stock, investments, etc.

These accessory receipts are otherwise of little importance, and represent in the case of the various companies only 1 to 2 per cent, at most, of the total revenue.

They should be detailed with care, for in general their collection gives rise to complicated operations; let us mention, for example, the proceeds of investments, which lead to the very interesting treasury and currency movements.

e) *Statistics of revenue per station and line.* — Statistics of revenue according to station are a purely treasury matter, but that which is specially important to

indicate is the distribution of the receipts according to line, each of these being assigned the share reverting to it from the cash receipts effected either through the stations or agencies of the system, or the stations or agencies outside.

These statistics have already been made the object of special study. They could not be dealt with again without our running the risk of repetition; nevertheless, this further reference to them was necessary, for in certain countries (France in particular) their importance is considerable in connexion with special conventions based upon the gross kilometric proceeds of the lines.

Let it suffice to recall the fact that the processes of apportionment or localization of revenue are approximate, and that their results, although nearly allied to the facts, cannot be expected to be absolutely exact.

D. — Statistics of expenditure.

The whole of the railway companies or administrations have adopted in principle a similar classification of expenditure, divided under four or five principal heads, *viz.* :

Central administration.
Working properly so-called, internal and general traffic.
Locomotive and rolling stock.
Maintenance of way and works.
Miscellaneous.

But we have only had to compare with each other the documents addressed to Mr. Hodeige in order to discover important differences in detail.

Thus, the cost of the checking and supervision of revenue are classed, sometimes among the general expenses, sometimes among those relating to traffic; pensions and retiring allowances are sometimes incorporated with the general expenses, sometimes charged in the augmentation of the staff expenditure of each section, sometimes, finally, placed among the miscellaneous expenses. The same thing occurs with regard to taxes, expenses of control, compensation and legal costs, which are placed either among the general expenses or with the miscellaneous.

We will examine these questions in detail in the second portion of the report, which deals with the classification of working expenses.

In regard to expenditure properly so-called, the statistics should draw a distinction between localized expenses and joint or undivided expenses, with a view to showing the yield of the lines or sections by keeping an account of their traffic. The joint expenses ought necessarily to be apportioned among the lines or sections; the basis of distribution are very diverse, and the results of none are free from all objection. Let us, however, cite the following bases : length of lines, mileages of trains, mileages of vehicles, axles, etc.

E. — Various statistics.

These auxiliary statistics serve either to give an idea of the density of the traffic, or to facilitate estimates of revenue or expenditure.

One can differentiate between the following statistics :

a) *Mileages of locomotives, of trains, of vehicles, distinguishing them according to passengers, goods, vans; axle mileage.* — The figures are derivable directly from the mileage returns, but unfortunately the figures published are not comparable with each other. One finds, indeed, notable differences arising out of the mileages of locomotives running light, ballast trains, service trains, double heading, and shunting which do not figure in the documents of certain systems.

b) *Mileages of staff, engine drivers and stokers, head guards, conductors, brakesmen.* — Few railway systems publish these statistics, the interest of which is evident from the point of view of social questions.

c) *Average composition of passenger, parcels, mixed goods trains; utilization of stock, gross tonnage, net tonnage average, useful load of a train, average tare.* — These statistics, arrived at either directly or by approximation, are extremely important as giving an idea of the general progress of the undertaking; they make possible the revision of the composition of the trains, and the best utilization of the stock.

d) *Expenses per kilometre of train, of locomotive, of vehicle per 1,000 ton-kilometres of goods. Consumption of locomotives; weight and price of coal, oil, grease; averages per locomotive-kilometre, per car-kilometre, per 100 ton-kilometres of goods.* — In France, the system of granting driver's bonuses for exercising economy gives a very great importance to the last-mentioned statistics.

By comparing with the number of kilometres run the consumption ascertained directly from the memorandum-books of the drivers, and the deliveries of fuel and other materials, one arrives at an exact appreciation of the value of the different types of locomotives under normal conditions.

The consumption may be made referable to the locomotive-kilometre or axle-kilometre, either upon the total distance run, or only upon the useful distance; these various methods render comparisons between the systems very difficult, and a unification of method would be highly desirable.

e) *Accidents, delays* — Statistics of accidents according to cause : derailment, imprudence, etc.; according to consequences : death, wounds, fire, etc., and whether to passengers, employees, strangers, are not kept in the same manner in all the systems.

As far as regards the employees, certain systems reckon the incapacity as from the

first day, others wait during a period of absence more or less long. It is necessary, therefore, to be very careful in comparing the figures, the more so as the systems which furnish particulars do not always indicate clearly the definitions adopted.

In general, one compares the number of accidents with the number of passengers carried, but the figures are anything but exact, by reason of the uncertainty as to the composition of the suburban trains, for instance. Here again, unification would clearly be advisable.

f) *Staff. Superannuation funds, pensions, etc.* — Very few systems give an analysis of their staff according to the nature of their employment. The figures would certainly be very interesting.

As regards the superannuation funds, the remarkable report of Mr. Lemercier to the Washington Session of the Congress contains all the data which could be desired in the interests of statistics and actuarial science.

F. — General statistics.

The whole of the statistics which we have just reviewed apply to each of the particular systems, but there is an obvious interest in grouping these according to country and completing by general information such as the following :

Successive position as regards length of the lines, details according to district, or administrative subdivision (canton, state, department, etc.).

General returns of revenue, dividends, taxes collected, averages, etc.

It is necessary, of course, to adopt precautions when comparing the figures of two countries. Averages can give only general ideas, and there is danger in drawing conclusions which may, very often, be found wholly inexact when one goes further into the details of the statistics.

III. — Uniform classification of working expenses.

A. — General remarks.

The examination of the reports, budgets and other documents which have reached us reveals essential differences between the existing methods of classification. It appears very difficult, therefore, to arrive at a uniform international classification of working expenses. Furthermore, although in France the authorities have laid down a uniform scheme for the presentation of accounts, we have discovered, without much trouble, notable divergencies between certain sections and items of the traffic accounts as rendered.

We have previously indicated that, as a general rule, the classification of expenditure was made under five headings (placed, according to the country, in a differen order), viz :

Central administration ;
Working properly so-called, internal and general traffic;
Locomotives and rolling stock;
Maintenance of way and works;
Miscellaneous.

The five groups respond to orders of ideas which are not clearly defined. Taking, for example, the French scheme, we will examine the points which invite discussion.

In principle, as regards each of these groups of expenses, one ought to follow administrative divisions, whether one distinguishes the services according to their general functions, or groups under the same heading the services converging in the same direction, such as the central services, the district and local services.

B — Expenses. — Central administration.

These expenses are made up of general outlays attaching to the working, properly so called, of the system, and of expenses arising out of the apportionment of joint general expenditure connected with the establishment, the working, and even other accounts (private estate, etc.).

In the first-named, one can also class the various rates and taxes, the cost of State supervision, assurances and indemnities in respect of casualities caused by the elements, compensation for accidents, legal costs.

The question is really, in fact, one of general expenses of administration which cannot be localized and charged in expenditure against any one of the four great services : internal and general traffic, locomotives and rolling stock, maintenance of way and works, construction. Nevertheless certain administrations group together all or part of these expenses under the title of " Miscellaneous Expenses." It seems more rational to reserve this denomination for expenses of little importance which will be indicated hereafter.

In this first category are classed, also, in France, the subscription expenses, allowances to superannuation funds, benefit funds, medical service. Would it not be better to charge them in augmentation of salaries? Are not grants to superannuation funds really a portion of salary, saved by the companies, on behalf of their employees?

The question is clearly open to controversy. The charging of these expenses in the general expenditure presents the great advantage of demonstrating *en bloc* their importance, and permitting the insertion in the reports of philanthropic considerations.

In any case, from the point of the international comparison, it is preferable that

they should be kept separate, for the system of pensions and benefits being essentially different in the respective countries, it is necessary to extract them again if they are incorporated in the service expenditure.

Finally, the expenses really indivisible, such as the costs of the directorate, the general management, the general services, the accountants' department, the securities and legal departments, ought to show clearly how they are made up.

Their composition is very different, according to the respective administrations; we have indicated above that the supervision of receipts was often viewed as general expenditure, for it sometimes forms part of the general accounts or constitutes a separate service. Other systems leave it under the authority of the traffic superintendent (internal and general traffic). This method of procedure (French) is open to criticism, and does not appear to merit recommendation.

As regards the apportionment of the general expenses among the various accounts which should bear them, we have pointed out that all the bases were more or less equitable, and that one appeared to adopt a distribution according to the so-called method of cash transactions.

C. — Working expenditure properly so called. — Internal and general traffic.

In these expenses, one can simply separate expenses of staff and of materials, or adopt the following divisions : central services, local services, train services (shunting), station service (traffic) and compensation.

This latter classification is far from being followed by all the systems, but those of which we have particulars revert practically to these great divisions, except as regards compensation expenses, which are sometimes considered as general expenses or applied to the services which have occasioned them. As the major portion of these indemnities proceeds from affairs of management and not of traffic, this distribution does not present great interest.

D. — Expenses of locomotives and rolling stock.

One can imagine a classification into staff and materials, but it seems preferable to effect an apportionment, as in the case of the working expenses, among : central services, local services, locomotives, rolling stock.

In general, this service deals not only with the construction, and the accounts should allow for the division of the general expenses of workshop management between these two categories of expenditure. It is necessary to call attention to the charging of costs of renewal of stock which is made under this expense-heading, when a vehicle is struck out of the inventory of stock in order to be demolished. Some systems charge these liquidations to special liabilities accounts in their balance-sheet, without diminishing their assets : the disadvantage of such a procedure is evident, since it causes to be shown among the assets vehicles which have

disappeared or become useless and definitely discarded. Let us mention that in the locomotive expenses one naturally finds the cost of fuel plus the customs-dues, tolls, etc., which are scarcely ever carried into general expenses.

It does not appear advisable to divide the expenditure of the central and local services wholly between the locomotive expenses and those of the maintenance of stock.

E. — Expenses of maintenance of way and works.

Following the principle previously indicated, the following method of division may be proposed :

Central services, district services, inspection of line, maintenance of track, of fixed material, maintenance of buildings, special repairs.

These various groups of expenditure are not found in all accounts. They appear, nevertheless, to form the minimum distinctions which should be made in registering the expenses of the maintenance by the way and works services.

F. — Miscellaneous expenses.

In this group are classed all the outlays which cannot be attached to any of the preceding services, but the categories which we have come across differ greatly according to the respective administrations.

It has been seen that certain systems include therein (wrongly, we think) subscription expenses classed more frequently among general expenses.

In France, there are charged in this group : hirings of stock, which would be better placed among the charges, or in the expenses of locomotives and rolling stock; land-taxes, which could easily be localized according to service, working, rolling stock, locomotives and way; stamp-duties and expenses and shares department, which are more properly general expenses; stores charges which, being loan charges, ought to be added to the latter; levies for reserve, which are general expenses.

Finally, it would be correct, in our opinion, to class in this group only the expenses of lines leased out in a particular way, although it may be possible as a rule to localize the latter according to service, which would reduce almost to nil the various expenses, the grouping of which has scarcely any utility.

CONCLUSIONS.

To sum up, we consider that statistics do not occupy, in the case of railway systems as a whole, the position to which they are entitled.

Sufficient account does not appear to be taken of the importance of the services which they render, whether by immediate utility in connexion with the accidental variations of traffic, of internal working, etc., or by retrospective returns which indicate the general progress of affairs.

It would be puerile to keep statistics for the mere pleasure of setting up tables of figures, but all those which we have indicated have a definite purpose, and will be of service, directly or indirectly, in acquainting the directors or heads of departments with the results of the working, and the utility of the means adopted to secure the efficacy of the services.

From a purely statistical point of view it would be advisable that the returns should be presented in analogous form by all the administrations, with a view to facilitating comparisons.

Should such a step be determined upon, it would be necessary to proceed methodically, commencing with the unification of the general returns serving as bases for the apportionments : length of lines, mileages of trains, of vehicles, of axles, etc., that is to say, with the statistics which we have named auxiliary.

As regards the uniform classification of working expenses, it woud appear very difficult to arrive at an understanding, since in countries like France, where under a general scheme prescribed by the superior authorities, one notices considerable differences of interpretation. At the most, one can only recommend a classification on the lines of the great administrative divisions : general services, internal and general traffic, locomotives and rolling stock, maintenance of way and works.

APPENDIX I.

Detailed list of questions relating to question XIV.

Note by the reporter.

We feel it our duty to justify, by a few observations, the list of questions we have prepared with a view to dealing with the subject which the permanent Commission of the International Railway Congress has been good enough to entrust to us, with regard to railways in countries other than Great Britain and America.

All railway administrations necessarily endeavour to organize their various services in the most practical and the least costly manner. But their respective positions are far from being identical, and the multiplicity of small points which differentiate them is reflected in the working expenses and the cost of the various units considered.

We will mention particularly, from this point of view, the dissimilarities arising out of the extent of the systems worked, the sections of lines which compose them, their complexities more or less marked, the numbers of stations and yards, the importance of the traffic, its distribution according to kind, the average mileages of the traffic units of the greater or less equilibrium of the traffic up and down, the cost of materials, the standard of salaries, the arrangements as regards leave, the limitation of the working-day of the staff, etc.

One finds oneself, then, face to face with very varying questions of fact, and whatever may be the development given to the statistics, it will always be very difficult to make anything like precise comparisons between the respective systems, on account of the impossibility of freeing these results from the conditions under which the lines are established or worked.

With regard to this very diversity, however, we are of opinion that, all imperfect as they may be, the comparisons cannot fail to be useful, and, in any case, interesting.

But we consider, also, that on account of the expense which the establishment of detailed statistics would involve, the data to be furnished should be confined within limits as simple as possible.

It is in accordance with this impression that we have drawn up our list of questions, which we believe the administrations generally will be able to answer without special trouble or difficulty.

Beyond doubt, many of those administrations possess data more extensive and very interesting. In order to enable us to take account of such data in our report, we express the hope that each administration will be good enough, in explaining to us its system of classification of expenditure, to let us have an enumeration, as complete as possible, of the statistical information at its disposal.

*

QUESTIONS.

I.

System of classification of working expenses adopted by each administration.

The organization of railway administrations includes in the ordinary way four chief services : the central administration or general management, including the secretarial department, the general service and common services, accounts and supervision ; the working service (internal and general traffic) ; the ways and works (permanent way and buildings) service ; the locomotive and rolling stock.

State in what respect the organization of your administration differs from this type.

The working expenses are naturally divisible according to service.

As regards the expenses of each service, these are subject to a certain classification.

Explain the system favoured by your administration, and enumerate, as fully as possible, the expenses included under each heading.

Are the expenses, classed and detailed according to service, also subject ton distribution among the *grande vitesse* and *petite vitesse* traffic, in other words, divided between the passenger train and goods train traffic.

Indicate what is done or could be done in this regard, adding any other information which would appear to you useful or interesting from the point of view of the establishment of the net cost per unit of traffic.

II.

Particulars of lines in operation.

(State the position on 31 December 1907, if possible.)

Length of lines worked.

—	Kilometres.
a) Double lines	
b) Single lines	
Total. . .	
of which kilometres are worked in common with other administrations.	
and kilometres serve goods traffic exclusively.	

Total extent of track ($2a + b$).	kilometres.
Number of intersections linking up the different lines, or, in other words, number of points of junctions of converging lines	

Gradients and curves.

—	Length.	Per cent.
Up and down gradients: of 1 to 5 per mil		
Up and down gradients: above 5 to 10 per mil		
Up and down gradients: above 10 to 15 —		
Up and down gradients: above 15 to 20 —		
Up and down gradients: above 20 to 30 —		
Up and down gradients: above 30 per mil		
Up and down gradients: Level		
Total		
or total equal to the length reckoned as track		
If need be, give the subdivision adopted by the company.		

Straights.

—	Length.	Per cent.
Radius of curves: 200 metres and less		
Radius of curves: more than 200 to 300 metres		
Radius of curves: more than 300 to 500 —		
Radius of curves: more than 500 to 700 —		
Radius of curves: more than 700 metres		
Total		
equal to the length reckoned as track		
If need be, give the subdivision adopted by the company.		

Development of shunting lines and sidings . . . . . | kilometres.

Industrial or private sidings.

—	Number.
Junctions with station or yard lines	
— — main lines	
Total	

Stations and yards, etc.

—	Number.
Stations and yards	
Stoppage-points (in open road, for the passenger service)	
Total . . .	
Exclusive of interior offices (town offices, auxiliary offices).	

III.

Particulars of rolling stock.

(There should be included in the effective force the stock in use, under repair, and in reserve.)

TRACTION STOCK.

—	Effective power on 31 December 1907.
Passenger locomotives	
Goods —	
Composite —	
Stations or shunting locomotives	
Steam or automobile cars	
Motor cars for electric lines	

Locomotives in general.

—	With 1 driving axle.	With 2 driving axles.	With 3 driving axles.	With 4 driving axles.	TOTAL.
Number					
Tractive power in kilograms (1)					

(1) The tractive power of the engines, tangentially to the driving wheels, to be calculated by means of the formula $\frac{6{,}714.5\ P\ d^2\ l}{D}$, in which:

P is the working pressure, in atmospheres;
d — diameter of the cylinders, in metres;
l — length of stroke, in metres;
D — diameter of the driving wheels, in metres.

This formula also gives the work, in kilogrammetres, of the engine per metre run.

Rolling stock.

Stock for passenger trains.

—	Effective power on 31 December 1907.		Total number of seats available.			
	Vehicles in general with or without bogies.	Bogie carriages.	1st class.	2nd class.	3rd class.	Together.
First-class carriages						
Second-class carriages						
Third-class carriages						
Composite carriages						
Luggage-vans						
Covered do						
Other vehicles for passenger trains : boxes, horse-boxes, carriage-trucks, etc.						
Total. . .						

Stock for goods trains.

—	Effective power on 31 December 1907.	Total tonnage.
Covered wagons of 10 tons and less		
— — of more than 10 tons		
Open trucks of 10 tons and less		
— — of 10 to 15 tons		
— — of more than 15 tons		
Special trucks, including those used for the track .		
Covered vans.		
Total. . .		

IV.

General results of the working.

(Indicate the year.)

Average length worked . . . . . | kilometres.

Receipts.

—	Francs.
Receipts from *grande vitesse* traffic or secured by passenger-trains. . . . { Passengers	
{ Luggage and other various traffic.	
Receipts from *petite vitesse* traffic or secured by goods-trains . . . . . { Goods by the ton	
{ Other traffic of various kinds . .	
Receipts other than from traffic	
Total. . .	
If the figures from receipts other than from traffic are relatively high, mention to what they relate and how made up.	

Expenses.

—	Francs.	Per cent.
Central administration and common services		
Working (internal and general traffic).		
Locomotives and rolling stock (renewing included)		
Way and works (renewing included)		
Miscellaneous expenses not classed		
Total. . .		
If the expenses not classed are relatively high, show how they are made up.		

Coefficient of working . . . . . .

STATISTICAL INFORMATION CONCERNING TRAFFIC.

Passengers.

—	1st Class.	2nd Class.	3rd Class.	Together.
Number of passengers.				
Mileage . . . . . Kilometres.				
Receipts . . . . . Francs. . .				
Average { mileage run . Kilometres.				
per passenger. { receipts . . Francs. . .				
Proceeds per passenger-kilom. . Francs. . .				

Goods by the ton or goods in bulk.

Number of tons.	
Receipts . . . . . Francs. . .	
Ton-kilometres.	
Average revenue { per ton . . . . . Francs. . .	
Average revenue { per ton-kilometre . . . . . Francs. . .	
Average mileage run of a ton . . . . . Kilometre .	

If the service freights are charged, indicate this, and give the particulars, if possible, separately.

PARTICULARS OF EXPENDITURE.

Subdivide, if possible, the expenses as follows :

Central administration and general services.

—	Francs.
Remuneration of the staff.	
Pensions and grants to relief and retiring funds.	
Other expenses	
Subdivide, if possible, between the traffic of the *grande* and *petite vitesse* respectively.	
Total. . .	

Working (Internal and General Traffic).

—	Francs.
Salaries, wages, bonuses	
Balance of account for the reciprocal employment of stock and for the use of termini, stations or common sections (1).	
Compensation for accidents, losses and damages	
Other expenditure	
Subdivide, if possible, between the traffic of the *grande* and *petite vitesse* respectively	
Total. . .	

(1) Certain administrations carry the assets balances to revenue and liabilities balances in reduction of revenue.

Locomotives and rolling stock.

—	Francs.
Maintenance and repair of locomotive stock	
— — of rolling stock	
Renewal of locomotive stock (1)	
— of rolling stock (1)	
Salaries and bonuses of engine-drivers, engine-men, firemen and brakesmen . .	
Other salaries and wages	
Fuel for locomotives	
Lubricating materials	
Other expenditure	
Subdivide, if possible, between the traffic of the *grande* and *petite vitesse* respectively.	
Total. . .	

(1) Indicate what is to be understood by renewal. Is it a question of cost of reconstruction or of repairing and replacing demolished stock, or of the value of the latter stock taken out of the inventories?

Way and works.

—	Francs.
Salaries and wages.	
Logs, rails and accessories	
Other expenditure	
Subdivide, if possible, the traffic of the *grande* and *petite vitesse* respectively . .	
Total. . .	

VARIOUS INFORMATION.

Average amount of remuneration, bonuses and compensation included, per employee and per year.

—		Francs.
Working	Platelayers	
	Head guards or conductors	
	Guards	
Locomotives and rolling stock.	Engine-drivers or engine-men	
	Firemen	
	Fitters, joiners, workshop employees	
Roads and buildings	Road-labourers (line keepers)	
Average duration of day of workmen on fixed posts		
— of day of engine-drivers, firemen, etc.		
Number of rest and leave days with continuation of pay : per year and per employee		
The case occurring, give the indications for category of staff		
Average cost of fuel per ton		
— — lubricating materials per kilogram		
— — oak and pine-wood per cubic metre		
— — rails per ton		

Mileage of trains and stock.

Trains.

KIND.	Number of kilometres run upon the administration's own lines.			Number of kilometres run by administration's trains on foreign lines.	Total number of kilometres run by administration's trains.
	The administration's trains.	Foreign trains.	Total.		
	a	*b*	*c* $(a+b)$	*d*	*e* $(a+d)$
Passengers :					
Single heading					
Double heading					
Goods :					
Single heading					
Double heading					
Service trains					
Total					
If mixed trains exist, show how assimilated, or give particulars separately.					

Average inclusive speed per hour { of passenger trains | of goods trains

*

Locomotives.

NATURE OF RUNS.	Number of kilometres run on administration's own lines.			Number of kilometres run by administration's locomotives on foreign lines.	Total number of kilometres run by the administration's locomotives.
	Administration engines.	Foreign engines.	Together.		
	a	*b*	*c* (*a* + *b*)	*d*	*e* (*a* + *d*)
With trains: passengers					
With trains: goods					
With trains: service					
Empty					
Train shuntings					
Station shuntings					
Total					

Indicate how are reckoned the distances run in shuntings for the train service (shuntings in course of route) and for the station service (making up and sorting out of trains).

Average distance run of locomotives per unit of effective power.

(Stock in use, under repair, and in reserve.)

—	Kilometres.
Passenger locomotives	
Goods locomotives	
Composite locomotives	
Station or shunting locomotives	
Steam or automobile cars	
Motor cars for electric lines	
Engines in general	

Number of hours of works of locomotives.

(Those in reserve, in steam, included.)

—	Hours.
For the passenger service	
— goods service	
— station shuntings	

Notify other statistical information considered of interest.

APPENDIX II.

Index number	NAMES OF RAILWAY COMPANY OR ADMINISTRATION.	Replied to questions.	DOCUMENTS ANNEXED.
1	Belgian State Railway.	Yes.	Memorandum of accounts and list of salaries in detail.
2	Alsace-Lorraine State Railway.	Yes.	Report for financial year 1908.
3	Bavarian State Railway	Yes.	
4	Oldenburg State Railway	Yes.	Report for financial year 1907.
5	Saxon State Railway	Yes.	Ditto.
6	Wurtemberg State Railway.	Yes.	
7	Austria, Hungary	Yes.	
8	Baden State Railway	Yes.	Report for financial year 1907.
9	Aussig-Teplitz Railway	Yes.	Working regulations.
10	Austrian Northern Railway.	Yes.	Report for financial year 1907.
11	Austrian Southern Railway.	Yes.	Details of accounts.
12	Hungarian State Railway	Yes.	Note upon the classification of working expenses.
13	Arad-Csanad Railway (Hungary)	Yes.	
14	Belgian National Suburban Railway (1)	No.	
15	Bulgarian State Railway	Yes.	Railway statistics for 1907.
16	Andalusian Railway	Yes.	Note upon the classification of working expenses.
17	Lorca-Baza-Aguilas Railway	Yes.	Ditto.
18	Madrid-Caceres Railway	Yes.	Ditto.
19	Spanish Northern Railway	Yes.	Ditto.
20	French State Railway.	Yes.	Note upon the classification of working expenses and specimen report upon a financial year.
21	Orleans Railway (2)	Yes.	Specimen of budget.
22	French Western Railway (2)	No.	Nil.
23	Paris-Lyons-Mediterranean Railway (2)	No.	Report to shareholders for financial year 1907.
24	Landes Local Railway.	Yes.	
25	State Railway, Algerian lines	Yes.	Specimen report upon a financial year.
26	Lorenzo-Marques Railway	Yes.	
27	Transvaal and Orange State Railway.	No.	Report upon the question submittet.
28	Italian State Railway.	Yes.	Note upon the accounts and administrations organization of the system.

(1) This administration does not work its lines itself.

(2) The replies to the list of questions are incomplete. Reference to statistical documents published by the French Ministry of Public Works.

Index number.	NAMES OF RAILWAY COMPANY OR ADMINISTRATION.	Replied to questions.	DOCUMENTS ANNEXED.
29	Luxemburg Prinz-Heinrich Railway	Yes.	General working accounts.
30	Norwegian State Railway	Yes.	Report upon the working for 1906-1907 and memorandum upon district accounts.
31	Dutch State Railway	Yes.	Working account for 1907.
32	Holland Railway Company	Yes.	Ditto.
33	Samarang-Vorstenlanden Railway (Java)	Yes.	
34	Beira-Alta Railway	Yes.	Note upon the classification of expenditure.
35	Rumanian State Railway	Yes.	
36	Sysran-Wiasma Railway	Yes.	
37	Russian State Railway St. Petersburg	Yes.	
38	Moscow-Vindau-Rybinsk Railway	Yes.	
39	Riazan-Ural Railway	Yes.	
40	Russian North Western Railway	Yes.	
41	Swedish State Railway	Yes.	
42	Stockholm-Rimbo Railway	Yes.	
43	Swiss Federal Railway	Yes.	Rules of accounts. Budget of statistical tables for 1907.
44	St. Gothard Railway	Yes.	
45	Ottoman Railway (1)	No.	

(1) Systems the traffic on which is of little importance.

[313. 385. (01]

REPORT N° 4

(North America)

By A. J. COUNTY,

ASSISTANT TO SECOND VICE-PRESIDENT, THE PENNSYLVANIA RAILROAD COMPANY.

CONTENTS.

Railway accounts and statistics in the United States :

a) Railway growth;
b) Governmental regulation;
c) Uniform accounts and statistics prescribed;
d) Uniform classification of revenues, expenses, and statistics;
e) Annual report for the Government;
f) Differences between old and new classifications;
g) Monthly reports for the Government;
h) Governmental purposes in promulgating uniform accounting.

Canadian and Mexican railways :

i) Uniform accounting and statistics.

North American railway accounting :

j) Annual reports and statistics for stockholders.

Operating expenses :

k) Uniform classification;
l) Watching revenues and expenses.

Conclusions.

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INTRODUCTION.

The inability of the reporter for America on " Statistics " to act in that capacity brought a request to the undersigned in March, 1910, to act as reporter by undertaking the treatment of this important subject. In the busiest part of the year, and with only a few months before the meeting of the International Railway Congress, it is impossible to do the subject justice, so I must confine the limits of this paper to the railways in the United States, Canada, and Mexico. I feel that the conditions under which the work was undertaken should be frankly stated at the outset, and I express my indebtedness to my own associates and friends in and out of the railway field for their cordial co-operation

American Railway Officers have for many years been deeply interested in the formulation and use of proper statistics and accounts, because without reliable statistics, and the knowledge they convey, the railways could not be progressively, efficiently or economically managed.

There were, however, other causes which made accounts and statistics essential and forced their evolution, among which may be mentioned: 1° competition through parallel lines which the laws permit to be built in any section of the country, accompanied by ruinous cutting and falling of rates and fares for the carriage of persons, goods, and property; 2° the recurring tides of great financial and industrial prosperity or depression averaging about one every decade; 3° the great distances covered by the lines, and the physical and climatic hindrances to be avoided, or benefits therefrom to be conserved; 4° the discipline of bankruptcy of those companies which disregarded commercial prudence, or were being financially exploited, and were overtaken by failure, followed by judicial sale and reorganization, requiring full publicity and adequate financial and operating statistics before more funds could be obtained from bankers or investors; and 5° the primary necessity of obtaining a record of the transportation service performed on all Divisions of the railways, so as to control the cost of its conduct, and the ned financial results.

Whatever principles underlie their compilation can best be shown by stating present American practice, accompanied by observations and conclusions as the result of experience so far acquired in the use of the present uniform system. The requirements are twofold—firstly, governmental, and secondly, for the owners, management, and all others interested. Both requirements date from the inception of railways. Usage demanded that reports and statistics for the owners and management should make the greatest advancement, but it required an inflexible mandate from the Government of the United States to submerge all individual railway preferences and place them sailing on the broad sea of uniform accounting and statistics.

Railway accounts and statistics in the United States.

a) Railway growth.

The great development of the United States and the continued prosperity and progress of that country is more largely due to, and more dependent upon, its railways than any other single factor. The expanse of territory occupying 3,000 miles from the Atlantic Ocean to the Pacific Ocean and 2,000 miles from the Great Lakes to the Gulf of Mexico, containing unrivalled agricultural and mineral wealth, was touched only in a few places, and to a limited extent, by the ocean, inland water and canal transportation routes and but sparsely inhabited before the advent of the railway. The railways were therefore welcomed as the true pioneers and the country devoted its energies to their construction as the quickest, most direct, and economical method of bridging the great distances and overcoming the adverse physical and climatic obstacles within its borders.

Prior to 1870 grants of lands, or money and franchises were made, without any important limitations, by the National Government to encourage trans-continental lines across the western territories, and by various States and municipalities, with the object of attracting population to their borders and securing the great commercial rewards and trade routes. The railways quickly spread throughout the country preceding, instead of, as in other new countries, following the settler, and, while the varying tides of prosperity and depression have left great marks on these commercial arteries on which the country is so dependent, as well as on the fortunes of those who invested their money therein and those who directed their operation, they have evolved well rounded and prosperous railway systems and serve a population of between 80,000,000 and 90,000,000 people.

The growth briefly sketched in decades is as follows :

1830	23	miles.
1840	2,800	—
1850	9,000	—
1860	30,000	—
1870	53,000	—
1880	93,000	—
1890	164,000	—
1900	193,345	—

On 30 June, 1909 there were 233,000 miles of railway, which in the year ending on that date had operating revenues of $2,494,000,000, or £500,000,000 sterling; operating expenses including taxes of $1,751,000,000; and net operating revenues of $743,000,000, or £150,000,000 sterling.

b) Governmental regulation.

It is not surprising that well-defined accounting and statistical methods should form a prominent feature in the operation and management of these extensive and privately owned systems, and that the National Government as well as the State Governments should desire to supervise their accounts.

It will be recalled that the United States of America consists of many independent and sovereign States, united by a written Constitution, thereby forming the United States, or National Government, which, in addition to exercising certain powers in all of the States as granted by the Constitution, directly governs the various territories not yet formed into States. While a few railroad charters have been granted

by the National Government in the territories from time to ttme under its control, because State governments did not exist therein, the railroad companies derive their powers and privileges from charters granted by the respective States in which the lines are located and operated, and exercise their powers and privileges subject to the laws of these States. The Railways are owned by individual stockholders who provide the capital therefor by the sale of capital stock, bonds, and other forms of securities, and are constructed, maintained and operated by Directors chosen by the stockholders, and officers and appointed by and subject to the Directors in accordance with the State laws. Nevertheless while privately owned and operated, the transportation business and service so generally affects the entire country by serving its necessity and convenience, that it is rightfully regarded in the nature of a public service and interest, and is therefore subject to regulation by the State, and as hereafter explained, by the National Government. This public interest is not confined to America, for it will be remembered that a large part of the capital was obtained in other countries and therefore these countries are interested in the welfare of American Railways, not only as investors, but also on account of the export of agricultural, mineral, and other products.

Under the Constitution, the National Government is granted the power of regulating commerce with foreign nations and among the several States, so that while all commerce within a State is subject to the authority of that State, all interstate and international commerce is regulated by the National Government. Within this plain constitutional provision: have grown in the past thirty years a vast body of national legislation and judicial decisions. The railroads were so necessary to the growth of the country that little attempt at regulation was made prior to 1870, but by building into new territory and by merger and consolidation the various lines became so extensive, and the population and business of the entire country which they serve have so well kept pace with their growth, that the desire for more specific regulation by the State and National Governments became general. It naturally began in the States, and, as the result of the " Granger Agitation " in the Western States in the 70's, many State Railroad Commissions were appointed, with powers to enforce the laws under which the railways existed, and especially to see that railway rates and service should be reasonable, and open without discrimination to all individuals and communities. Many of these railroad Commissions, and among them some of the most influential, like that of the State of Massachusetts, organized in 1869, possessed only advisory and recommendatory authority, and relied for their effectiveness largely upon public opinion, but gradually the powers of the Commissions have been extended and become mandatory. During the past few years, several of them under the title of Public Service or Utility Commissions, have been given not only mandatory powers as to steam railways, but their authority has been extended to electric railways, telegraph and telephone lines and their accounts, so that a uniform system of accounting might be established, and the results published by the State for the information

of the authorities, the citizens and security holders. The powers of these Commissions extend not only to accounting, but in many cases to approving the issues of stocks and bonds, and other important matters not within the scope of this paper, such as betterment of the transportation service and facilities generally, and the rates to be charged therefor.

c) Uniform accounts and statistics prescribed.

Railway regulation was not long confined to the State authorities, for in the decade ending 1880, the question was given extended consideration by the National Government, but the necessity for national legislation was not apparently ripe, and no decisive action was taken until the passage in 1887 of an Act to regulate commerce, known as the Interstate Commerce Act. This Act marked the first step of the Government to prescribe a uniform accounting system for interstate railways, by a Commission called the Interstate Commerce Commission. Many of the railway companies had observed a general classification of operating expenses, and the principles and practice of railway accounts and statistics had been formulated and many of the Railway Companies published admirable reports for years preceding this Act, but it is from the passage of this law, and the subsequent notable expansion in railways and their revenues, expenses and finances, that the public for the first time sees a definite foundation for the present uniform accounting and statistical system. The provisions of the Interstate Commerce Act of 1887 regarding accounting, required annual reports covering capital issues and payments; physical characteristics; operating, traffic and financial statistics; information as to rates and fares; and the contracts with other railways, and gave the Interstate Commerce Commission the right in its discretion to prescribe a uniform system of accounts.

Regulation by Government Commission was a new feature in the United States, and it should be recorded to the credit of American railways that instead of antagonizing the legislation regarding uniform accounting, they formed the Association of American Railway Accounting Officers in 1888 with officers representing 72,000 miles of railway and convened in the Spring of that year to consider a form of annual report to be made to the National Government, and the Act of 1887 was made effective by the friendly co-operation of the railways, for its provisions could not be enforced on account of the inadequacy of the money appropriated. This co-operation between the railways and the Government still continues, and while naturally the views of the Government and Railway officers have sometimes differed, a great work has been accomplished which could not have been effected in any other way, *i. e.*, that of evolving a uniform classification of accounts so far as it is possible to obtain one. This was no easy task for a country with competitive railway systems widely differing in geographical location, in the standard of their development, and in the character of the through and local traffic and their several interests, and it demanded wide experience, nature judgment, and additional expense to reach sound, broad minded conclusions.

This Act performed good service, but it did not produce absolute uniformity in accounting or statistics. It gave time for ample reflexion, the development of uniform account headings, and the test of experience, and so paved the way for the practice of uniform accounting, but after nearly twenty years, it was natural in this active young country that its provisions should be modified and the powers of the Interstate Commerce Commission extended. This was accomplished by the passing of the Act of 1906, known as the Hepburn Act, which was designed to regulate more important public questions than uniform accounting, but the provisions regarding the latter were materially broadened, and, coupled with heavy penalties for non-observance, which caused little surprise, as the law was passed in the heat of public discussion as the concluding chapter in legislation against railroad rebates.

Under this law of 1906, amending the Interstate Commerce Act of 1887, uniform accounts and statistics are now kept and reported to the Commission by all railroads.

Its general provisions regarding our subject, are that the Interstate Commerce Commission (consisting of seven members appointed by the President of the United State, with the consent of the Senate, to serve for a period of seven years and devote their entire time and attention to the business of the Commission) is authorized to require annual reports from all railways engaged in interstate commerce and to prescribe the manner in which the reports shall be made, require specific answers to all questions upon which it may need information, and to prescribe a time within which all railways subject to the provisions of the Interstate Commerce Act shall have, as near as may be, a uniform system of accounts and the manner in which such accounts shall be kept. The Commission has at all times access to all accounts, records and memoranda, subject to the Act which regulates Interstate Commerce, and it is unlawful for railways to keep any other accounts, records or memoranda than those prescribed or approved by the Commission and the latter may employ Special Agents or examiners with authority to examine any and all accounts, records and memoranda kept by the railways. In case of refusal to keep the accounts, records and memoranda or to submit same to the inspection of the Commission or its authorized examiners, a forfeit of $500 for each offence is recoverable by the Government of the United States.

False entries, mutilation of records, or the keeping of accounts or records other than those prescribed or approved by the Commission, is a misdemeanor and upon conviction in a proper court of the United States, a fine or term of imprisonment or both fine and imprisonment may be imposed.

Examiners (employed by the Commission) are subject to fine and imprisonment if they improperly divulge any facts or information coming to their knowledge.

The annual reports are made under oath for the twelve months ending 30 June in each year, and must be filed before the 30th day of September next following, unless additional time is granted by the Commission. If the reports are not filed or specific answer is not made to any

questions authorized by the provisions of the Act, the railway in default shall forfeit to the United States the sum of $100 for each and every day such default exists. The Commission also has authority to require railways to furnish monthly reports of earnings and expenses, and to impose the forfeiture above provided. The Commission may prescribe the forms of any and all accounts, records and memoranda to be kept by the railways, including the accounts, records and memoranda of the traffic movement as well as of the receipts and expenditures of money.

In this same period, the powers of the State Railroad and Public Service Commissions were also extended, and by co-operation between the State Commissions and the Interstate Commerce Commission, a general scheme of uniform accounting has been established, based on the uniform accounting system previously used and revised with the advice and assistance of railroad officers. The Railways in every reasonable way have tried to observe the system, and assist the Commission, so that the classifications promulgated thereunder may be universally used by all lines, become permanent, and satisfy all essential demands of the governing powers, as well as those who have furnished the money to construct and successfully administer the railroad lines of the country.

With the exception of a few principles, the uniform accounting system adopted by mutual co-operation, and made compulsory by law, will prove practical in working, especially if dominated by good sense and patience on both sides, and if the constitutional principles of railway regulation and supervision, to which the State and National governments are committed, are observed in lieu of railway control or administration apparently sought to be obtained through accounting or other methods, without assuming the responsibility of ownership and management. Under private ownership and governmental supervision and regulation, the railways have grown in less than eighty years to a commanding position, and have been the chief agencies which have populated the country, developed its manufacturing, agricultural, mineral, and other resources, carried prosperity with them, and while their total net revenue has materially increased, their rates to the public have steadily decreased. They have continuously improved the transportation service by capital expenditure ably seconded by the use of surplus income, which corrected the necessary bonus issues of capital stock in their early history for which no cash was paid, and have also borne the constantly increasing burden of various forms of taxation imposed by the very communities which were founded, and their material prosperity secured, by railroad construction and operation. The record of private ownership and governmental supervision judged from any reasonable standard therefore needs no defence.

d) Uniform classification of revenues, expenses, and statistics.

Under the Interstate Commerce Act, as amended in 1906, six classifications have been issued for steam railway covering Operating Revenues; Operating Expenses; Road and Equipment Expenditures for new lines, or important extensions of

existing lines; Locomotive Miles, Train Miles, and Car Miles; Outside Operations, Revenues, and Expenses; Expenditures for Additions and Betterments to existing lines, to which reference is hereafter made. A very clear explanatory text accompanies all of these classifications, showing what should be included in each primary account. The Commission has also issued a form of General Balance Sheet Statement, but this and the Classification of Additions and Betterments, are open to modification, because a few principles have not been disposed of to the mutual satisfaction of the Railways and the Commission.

e) Annual report for the Government.

Monthly and Yearly reports are required, and also reports on special features may be called for. These reports and classifications, which have been fully revised since 1906 and issued by the Interstate Commerce Commission, constitute the uniform accounting system, and reach a conclusion in the tables which from the *Annual Report* to the Commission — hereto attached — marked appendix A.

The requirements of each table (numbered below) in the Annual Report will be examined and in this way the uniform classsification of operating expenses, as well as the principles of statistics of railways in operation will be considered.

1. The name of the Railway Company, with a summary of the laws under which it has been incorporated, and if an amalgated or consolidated company, the name of the various constituent companies.

2. The Director and principal officers.

3-4. The active and inactive corporations controlled by the respondent railway and the nature of that control.

5. Particulars as to stockholders' meetings, closing of stock books, voting rights possessed by the shares; also whether the respondent company is controlled by any other corporation or individual and the nature of such control.

6-7. The name, termini and mileage of every railroad company, the operations of which are included in the report, whether fully or jointly owned, leased, or operated under contract.

8. " Outside Operations " and " Other Properties " covered by the capital of the respondent company, consisting of boat and ferry lines, harbour terminal transfers, cab and omnibus service, hotels, restaurants, dining car service, and other items listed in full in Table 33. The other properties consist of government land grants, coal, lumber, and other business properties not included in the railway lines owned or " Outside Operations ".

9. Railways acquired by respondent company for operation through lease or agreement; and railways assigned to another company for operation through the same medium.

10-14. Statement of capital stock, funded debt, equipment trust obligations, setting forth the various kinds of capital stock, and the dividends declared thereon during the year, also the various kinds of funded debt, whether mortgage bonds, collateral bonds, plain bonds, debentures and notes, income bonds, miscellaneous obligations, and equipment trust obligations (the latter being used to purchase new locomotives and cars) of which a cer-

tain portion of the principal matures every year. It will be noted in these statements of stock and funded debt, that the purpose of the issue and amount realized therefor must be stated; also the total par value of either stock or bonds held by the Company itself, whether in its treasury on in sinking or other funds connected with the corporation.

14. To remind one that all railroads are not profitable, there is a statement of certificates issued while the company is in the hands of a Court Receiver, instead of being operated under the direction of a President or other officer, elected by the stockholders or appointed by the Board of Directors.

14. Current assets and liabilities in details.

15. Security for the various forms of funded or bonded debt, or other fixed obligations, outstanding.

16. Expenditures for Additions and Betterments. They are divided under 32 primary accounts, showing whether same were charged to capital, special funds or to surplus income. These expenditures consist of additions to, or betterments of, the existing railway, its facilities and equipment.

In issuing the Classification of Expenditures for Additions and Betterments, the Statistician of the Interstate Commerce Commission states :

As the Form of General Balance Sheet Statement to be promulgated by the Interstate Commerce Commission to take effect on 1 July, 1909, provides that all expenditures for a new construction and for additions and betterments should be charged to the proper accounts under the caption « Property Owned as Investment, » *viz.*, the railroad and its rolling stock, it is no longer permissible to charge such expenditures to Income, Profit and Loss, or Special Funds *in such a manner as to exclude any expenditure for additions and betterments from the property accounts in the balance sheet.*

Additions and Betterments include additional structures, facilities of equipment not taking the place of anything previously existing, and the enlargment or improvement of existing structures, facilities, or equipment, or the propor portion of the cost of new structures or facilities of an improved or higher class taking the place of others previously existing. Expenditures for additions and betterments amounting to less than $200 (with several exceptions) should be charged to the appropriate accounts under Operating Expenses or Outside Operations, except as otherwise provided in the Classification. In case it becomes necessary directly in connection with betterment or improvement work to abandon any property, the cost of replacing the abandoned property in kind, plus the cost of removal but less the value of salvage, should be charged to the appropriate accounts under Operating Expenses. In case, however, the amount so chargeable is large, and its inclusion in a carrier's operating expenses for a single year would unduly burden the operating expense accounts for that year, the carrier may, if so authorized upon application to the Insterstate Commerce Commision, charge such cost to the Property Abandoned account provided in the Form of General Balance Sheet Statement to be charged off to operating expenses in a series of years. This may be provided for in advance by the reserve account mentioned in the following paragraph.

When property is abandoned and not replaced, the original cost (estimated, if not known) should be credited to the appropriate additions and betterments accounts and charged, less salvage, to Profit and Loss Account, to which should also be charged all incidental expenses directly connected with the abandonment. If so authorized upon application to the Interstate Commerce Commission, however, a carrier may set up operating expense depreciation accounts under "Maintenance of Way and Structures" for the purpose of creating a reserve to which (instead of Profit and Loss (should be charged the original cost, less salvage, of the property (other than land or equipment) abandoned, and all incidental expenses directly connected with the abandonment.

This classification applies exclusively to additions to, or betterments of, existing main and branch lines and their appurtenances and equipment. At the end of the year, the items are merged into Road and Equipment Account.

17-18. Road and Equipment Expenditures. These expenditures are classified into three general accounts (I) Road; (II) Equipment, and (III) General Expenditures, and subdivided into forty-eight primary accounts. The purpose of tables 17 and 18 is to show in detail the expenditures during the year for new main and branch lines, and extensions to existing lines, and additional equipment, with a clear statement showing the amounts thereof charged against capital, and charged to special funds or income, and the total cost to date, with a summarized statement showing cost per mile of railway, under each of the three general accounts.

19-20. The Income Account embraces the grouping of all the accounts covering Income for the year, and shows the gross and net results thereof. The principal feature of the Income Account is that the railway operations, revenues and expenses are kept independent of any other operations owned or directed by the Company. This will be more clearly emphasized in dealing with the various revenue and expense classifications.

21. Profit and Loss Account, in which must be shown in detail all debits and credits of any kind made during the year and the purposes of same.

22. Operating Revenues. It will be noted that these are divided into two general accounts: (I) Revenue for Transportation and (II) Revenue from Operations Other Than Transportation, such as station and train privileges, advertising in stations and on trains, new stands, parcel room receipts, telegraph and telephone service, car service, which is the demurrage charge against shippers for delays in unloading cars, etc., all of which are incidental to transportation, and are not outside or auxiliary operations. The foregoing general accounts are divided into twenty-one primary accounts, including two primary accounts, known as Joint Facilities Accounts, which are provided so as to separate revenues derived by a railroad from the operation of joint tracks, terminals, or facilities, which are either payable to, or receivable from, other companies.

In issuing this Classification of Operating Revenues, the Statistician of the Interstate Commerce Commission states: "It will be observed that the primary accounts are so drawn as to show, firstly, the amount earned for the transportation of

freight, upon which should be based the computation of revenue per ton per mile and revenue per freight train mile; secondly, the amount earned for the transportation of passengers, from which may be computed the revenue per passenger per mile; thirdly, the amount earned from all transportation on passenger trains, from which may be computed the revenue per train mile; and, fourthly, other revenue from transportation service, namely, switching revenue, special service train revenue, and miscellaneous transportation revenue. In addition to revenue from transportation, the Revenue Account includes additional primary accounts which cover revenue from operations incident to transportation, the expenses incident to which are included in Operating Expenses."

23. Shows in detail all deductions from the Operating Revenues, consisting of overcharges, over collections, switching charges, fares refunded, etc. On account of the large amount of work involved, this classification in 23 items has been waived for the present.

24-25. Showing all stocks of other railway corporations owned, and the condition under which they are held by the carrier, *i. e.*, pledged or unpledged, and whether its own stock, the stock of a company whose property forms a part of the operating system, or the stock of a company not forming part of the operating system, the dividends declared thereon and the valuation at which the stocks so owned are carried into the General Balance Sheet.

26-27. Similar tables for bonds.

28. Information required covering ownership of all stocks and bonds other than those of railway companies. The object of tables 24 to 28 is to afford a detailed view of the securities and stocks of all kinds owned by the railway company, and the value at which they are reported to the stockholders, and also to indicate the range of the Company's activities and interests.

29. Sinking, Improvement, Renewal, Injury, and other Special Funds, held or set apart by the company for specific corporate purposes. No funds for the benefit of employees, such as sickness, accident, saving or insurance funds are included.

30-32. Operating Expenses. These expenses are classified under five general accounts (I) Maintenance of Way and Structures; (II) Maintenance of Equipment; (III) Trafic Expenses; (IV) Transportation; and (V) General Expenses. These general accounts are further subdivided into 116 primary accounts as shown in these tables hereto attached. The ratio of the total of each primary account to the general account under which it belongs and to the total Operating Expenses is also shown.

In issuing this important classification, the Statistician of the Interstate Commerce Commission stated: "It is eminently appropriate that public acknowledgment should be made to the Association of American Railway Accounting Officers, and to the standing and special committees appointed by that association, for their hearty co-operation in working out the details of this Classification. In no other way would it have been possible for the Commission to avail itself of that special knowledge and expert experience necessary for the successful accomplishment of the task undertaken."

33. Outside Operations, detailed statement of, *viz.*, hotels and restaurants, ferry and boat lines, harbour terminal transfers, cab and omnibus service, dining, sleeping, and chair cars, etc., showing revenues, expenses and net revenue or deficit of each class. Other Properties, Revenues, Expenses, Taxes and Income or Loss on, such as land grants, coal and lumber properties, etc., in detail.

It did not seem desirable to print the entire classifications of the various Outside Operations, but to illustrate its general scope, the general and primary accounts for Ferry Lines are shown in table 62 of appendix A.

In issuing this Classification, the Statistician of the Interstate Commerce Commission states : " Outside Operations are facilities operated or services rendered by a railway other than those incidental to transportation by rail, the revenues and expenses of which, if included in the carrier's accounts, impair the significance of statistics prepared from such accounts. The purpose of these accounts is to segregate from the accounts of transportation by rail the revenues and expenses of all services not necessarily incident to such transportation and not necessarily rendered by all carriers operating under similar conditions. " Transportation by rail " includes the receipt, transportation, and delivery of traffic, such storage of freight as is necessary to the operation of the railway, all special facilities necessary for the handling of special classes of traffic, such as coal and ore docks, coal transfers, and facilities for the receipt and delivery of live stock, and such car ferries as are actual subtitutes for bridges and tunnels. It does not include local collection and delivery (except switching), or transportation by water, except car ferries as above provided. The rule which should govern in determining what items of expenses should be charged to outside operations is that the rail expense accounts should show the full and true cost of conducting transportation by rail, even though such disposition results in an incomplete or partial statement of the cost of conducting the outside operation. No charge should be made to outside operations if the effect of such charge would be to relieve the rail operation *of an expense that would be charged against it if no outside service were operated.* When a specific charge is made for the service or commodity furnished by the outside operation, such charge consitutes the revenue of the operation.

When the through rate contains an arbitrary division or allowance, intended to cover the service of the outside operation exclusively, such arbitrary division or allowance is to be considered the revenue of the operation and is to be apportioned on local as well as through business. Charges against the operating carrier for services or product should be at cost, and should be credited to the account entitled " Other Operations, Cr.," which has been introduced in operating expenses of outside operations for that purpose. Whenever a credit is made to that account, a charge of like amount should invariably be made to the appropriate operating expense account of the rail department or of some other outside operation. The maintenance of facilities for transportation or other service, or distinct portion thereof, assigned exclusively to an outside operation should devolve upon the outside operation when sepa-

rable from the expense of maintaining the railway. The maintenance of facilities not so separable should be borne by the railway when employed only incidentally by the outside operation and by the outside operation when employed only incidentally by the railway.

34. Rents Receivable from use of joint tracks and joint yards and terminals.

35. Rents Receivable from lease of road and Miscellaneous Rents and other Miscellaneous Income.

36-37. Rents Payable divided as in tables 34 and 35. Other Deductions from Income and result of operation of separately operated properties.

38-39. Hire of Equipment, divided under three headings (A) Equipment Leased, subdivided under Rents Accrued Receivable and Rents Accrued Payable; (B) Equipment Interchanged, divided under I. Accrued on Equipment Borrowed and II. Accrued on Equipment Loaned; (C) Private Cars, showing name of owner, description, number of car miles, rate of compensation, and amount.

40. Taxes and assessments, divided under two headings (A) Company's owned and proprietary lines; (B) Company's Leased and Operated Lines.

41-42. Comparative General Balance Sheet showing changes that have taken place in the financial condition of the company during the year covered by the report (1).

43. Extensions and physical changes of road. Decreases in mileage by straightening line. Leases taken or surrendered. Consolidations or reorganizations effected. New Stocks and Funded Debt issued. Changes in holding of Stocks and Funded Debt. All other important financial changes.

44. Contracts or agreements entered into with other Companies or persons concerning transportation of freight or passengers, such as transportation of mail for the government and with Express, Sleeping, Parlor, and Dining Car Companies, Telegraph and Telephone Companies, etc.

45. Employes, divided into eighteen classes, with number of days worked, total yearly compensation and average daily compensation, with the total salaries distributed between Maintenance of Way and Structures, Maintenance of Equipment, Traffic Expenses, Transportation Expenses, General Expenses, and Outside Operations.

46-47. Traffic and Mileage Statistics, *viz.*

Passenger Traffic:

1. Number of Passengers Carried Earning Revenue,
2. Number of Passengers Carried One Mile,
3. Number of Passengers Carried One Mile per Mile of Road
4. Average Distance Carried, miles,
5. Total Passenger Revenue,
6. Average Amount Received from each Passenger,
7. Average Receipts per Passenger per Mile,
8. Total Passenger Service Train Revenue,
9. Passenger Service Train Revenue per Mile of Road,
10. Passenger Service Train Revenue per Train-Mile.

(1) This form of Balance Sheet has been changed, and a copy of the revised form is inserted in the Appendix.

Freight Traffic :

11. Number of Tons Carried of Freight Earning Revenue,
12. Number of Tons Carried One Mile,
13. Number of Tons Carried One Mile per Mile of Road,
14. Average Distance Haul of One Ton, miles,
15. Total Freight Revenue,
16. Average Amount Received for each Ton of Freight,
17. Average Receipts per Ton per Mile,
18. Freight Revenue per Mile of Road,
19. Freight Revenue per Train-Mile.

Total Passenger and Freight Traffic. — Operating Revenues; Operating Revenues per mile of road and per train mile; similar statistics covering Operating Expenses; net operating revenue or deficit and the operating revenue or deficit per mile of road; Average number of passengers per car mile and per train mile; average number of passenger cars per train mile; average number of tons of freight per loaded car mile and per train mile; average number of freight cars per train mile; average number of loaded and empty cars par train mile; average number of loaded and empty cars per train mile; average mileage operated during the year.

Locomotive Mileage, Car Mileage and Train Mileage in revenue and non-revenue service, covering freight and passenger traffic. (See details in tables 46 and 47, appendix A.)

These are among the most important statistics required by the Commission and are divided into sixty-six separate items.

48-49. Freight traffic movement (Company Material excluded), divided between Products of Agriculture, Animals, Mines, Forests and Manufactures, Merchandise, and subdivided in various commodities, and showing the tonnage originating on the road of the railway, the tonnage received from other carriers, the total tonnage, and the percentage of the total tonnage represented by each commodity and each group of Products.

50-54. Detailed description of equipment (*viz.*, Locomotives, passenger and freight cars, and repair cars), its capacity, the additions and retirements during the year, etc.

55. Mileage of single track, double track, third track, four track, yard track, branches, sidings, etc. Mileage divided by States operated and owned, the new lines constructed and miles of rails used therefor.

56. Tie renewals during year, number, and average price; rail renewals during year, tons, weight per yard, and average price at distributing point. Consumption of fuel by locomotives divided between anthracite and bituminous coal, cord wood, fuel oil, with the miles run and average pounds consumed per mile for locomotives in various classes of service.

57. Accidents of all kinds and how incurred.

58. Characteristics of road by divisions and branches, showing alignment and profile.

59. Bridges, trestles, tunnels, etc., material of which constructed and their maximum and minimum length; overhead highway crossings, overhead railway crossings. Gauge of track. Telegraph Lines along the railway owned or operated by the railroad company, or owned or operated by another company, mileage thereof, etc.

This completes the present annual

report requirements, but I here insert and mark.

60-61. The new form of General Balance Sheet. This has been made partially historical, and laden with many accounting technicalities that prevent it from being easily understood by the investor, and it must inevitably undergo further revision before reaching its permanent form. I also add and mark as number.

62. Ferry Lines, general and primary accounts, as an illustration of what is now required as to each operation outside of Railway Transportation.

f) Differences between old and new classifications.

It will be interesting to note the chief differences between the mandatory new classifications placed in effect since 1906 and the rather optional old classifications, which are :

Firstly. — The separation from railroad results of all Revenues and Expenses not incidental to rail transportation the revenues and expenses of which, if included in rail accounts, would impair the value of statistics compiled therefrom. All revenues and expenses not incidental to railway transportation are embraced under the classification of " Outside Operations."

Secondly. — The net amount paid to any other companies for the use of equipment instead of being an operating expense is now a fixed or obligatory charge against Income — " Hire of Equipment " — because to the extent that it is necessary to hire equipment by paying rental therefor, a company is deficient in investing the capital necessary to furnish sufficient equipment for its own traffic and instead is using the capital of other companies by paying an amount supposed to represent interest thereon. This is not necessarily an evidence of bad management as the line may be part of a through route and dependent upon a connecting line for a large part of its traffic, and therefore not in a position to dictate whose cars shall be used. The company receiving a net payment for the hire of equipment cannot report it among its operating revenues, or as a deduction from operating expenses as heretofore, but must show it as a separate item under " Other Income, " for the converse reason to that given above. It is interest on capital used by others. When the Hire of Equipment accounts, which of course covered principally the interchange of freight cars, were first established, it was ordered that of the per diem charge, which then had been fixed by the railroads at 50 cents, 12 cents thereof estimated to represent the cost of depreciation and maintenance should be either charged or credited to Operating Expenses, but as this amount was entirely an estimate, and as a large number of repairs had to be made entirely at the expense of the using Company, it was afterwards concluded that the whole amount paid or received was more in the nature of a rent than as a reimbursement for repairs or depreciation. Since then this per diem charge has been as low as 25 cents instead of 50 cents, because under depressed business conditions all of the lines had many idle cars.

Thirdly. — Joint Facilities Accounts : These accounts like Hire of Equipment can show either a debit or credit balance,

dependent upon the extent to which a company uses the tracks, terminals or facilities of other companies. Their principal function is to eliminate duplication by showing the entire cost of operating any jointly used terminal, station, yard or tracks in the primary accounts of but one carrier, *viz.*, the owning or operating company, instead of having these charges distributed between primary accounts of all the carriers participating in their use, and in this way show the true cost of operation, regardless of their final distribution through the use of the "Joint Facilities Accounts" of all Companies concerned. They are also designed to show under the primary expense accounts first, the expenses of the company's owned and operated lines, and second the net expense of earning the revenue show. In the United States, it has become a general practice to use part of the tracks, terminals or facilities of other railway companies instead of constructing independent facilities, which would be a duplication of those existing and a waste of capital. Such arrangements generally require the joint user to pay to the owner a proportionate share, based on the number of trains, car and engines, or other traffic units, of 1° interest on the valuation or cost of the tracks and facilities used and 2° of the cost of maintenance, operation and administration and taxes. Under the former methods, the owning company would charge its operating expenses with all of the expenses of maintenance, operation and administration of the joint facilities used with another company or companies, and would include as part of its operating revenues or other income the rental received from the using company, and the using company, and the using company would charge the entire rental so paid; *i. e.*, its share of the interest as well as the operating cost to its own operating expenses or fixed charges or depending upon the judgment of its officers the rental, in whole or in part, might be used to affect the revenues, operating expenses or fixed charges of both companies, the practice being by no means uniform, but the amounts being reflected in the accounts of all companies, being gross and not net, led to considerable duplication. Under the present system of accounting, the amounts received from the use of joint facilities are separated and placed in special primary accounts. The proportion of the interest upon the cost or value of the joint facilities and the taxes received from the tenant company using the same, is not considered as operating revenue, but is reported in the general income account as an item of other income under the heading of "Joint Facilities—Rents" and is regarded as interest return to the owning company upon such portion if its capital as is used by others. In the case of the using company, it is regarded as an obligatory interest charge and shown under the heading "Joint Facilities—Rents," because to that extent it is paying interest upon the capital for tracks, terminals and facilities which another company has provided. The cost of maintenance, operation and administration of such joint facilities is shown in separate itemized debit and credit primary accounts, so that only the net amount paid by a company becomes a part of its operating and maintenance expenses, and if a net amount is received, it is treated as a separate and specific credit, and reduces the

expenses to the amount actually borne.

Fourthly.—Formal Depreciation charges on equipment have been made a part of Operating Expenses; and with the consent of the Commission, Depreciation Accounts may also be established for Maintenance of Way and Structures.

Fifthly. – Premiums realized on the sale of *Capital Stock* must be permanently carried in the Balance Sheet under Capital Liabilities, thereby specifically earmarking the same for Capital Expenditures, and in this way prevent the possibility of their being merged with the Profit and Loss account and used otherwise than as above. This amount can be off-set by any discount suffered on stock, but under the laws of many States, railroad companies are prohibited from selling their stock at less than par.

Discount on Stock must be similarly carried in the Balance Sheet until extinguished by premiums realized on capital stock of the same class. If the stock is to be retired or converted, this can be charged to Profit and Loss or against any premium realized on such stock at the date of its retirement or conversion.

Premium realized on bonds or funded debt must be credited to Income in equal annual instalments during the life of the bond as will extinguish the premium, or credited to Profit and Loss. The credit to Income in any one year must not exceed the amout of the annual instalment.

Discount on Bonds : The discount on Bonds is similarly charged to Income or to Profit and Loss. If the premium realized is greater than the discount on bonds, the latter may be deducted from the premium and the balance shown in the General Balance Sheet.

Discount on Stock or bonds cannot be included in the cost of railway or equipment but must be shown and dealt with as above indicated. The preferable method would appear to be to at once charge the discount against Profit and Loss so as not to leave too much to posterity or trust to realizing premiums.

Sixthly. — Expenditures for Additions or Betterments tothe railway, or its equipment over the cost of replacing in like kind, or original cost, respectively, are recognized as elements of operating cost and can not be charged to operating expenses, but must be shown upon the General Balance Sheet as part of the cost of road or equipment.

The object claimed for the Depreciation Accounts was to guard primarily against an *over*statement or understatement of the net revenues by including such depreciation as part of the operating costs and to spread the charges for replacement evenly over the years rather than have the charge made or omitted as it suited the financial convenience or necessity of the railways, and the purpose of Additions and Betterments Classification was to limit operating expenses strictly to maintenance and operating outlays and depreciation, and so guard against an *under*statement or overstatement of net operating revenues by excluding therefrom additions to, or improvements of, the property or equipment, and as the same time including therein all proper charges for replacement.

I may say here that while the provisions governing Depreciation and Additions and Betterments are, from a theoretical standpoint, reasonably and logically expressed, and the underlying principle of absolute

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uniformity is preserved, yet from a practical standpoint, a certain amount of arbitrary control is exercised through the medium of these accounts, and proper operating results depend entirely upon their reasonable enforcement. The provisions enter the domain of railway management in deciding what shall constitute an operating expense, and a capitalizable asset. This is especially so when the fact is recognized that all additions and betterments are not proper items for capital issues, and should not from a practical standpoint be carried into the general balance sheet as a capitalizable asset. The accounting rule of the Commission for equipment replacements is open to objection in that it requires that operating expenses shall bear a replacement charge only to the amount of the original cost of the discarded or destroyed equipment, without regard to whether labour or material costs have increased, by this difference understating operating expenses, and also inflating the true value of the equipment. In valuing any asset on the Balance Sheet, it is also desirable that if any deduction is to be made because any part thereof has been paid out of the surplus income, the fact should be clearly shown by deducting such amounts, either specifically or otherwise, before carrying the final cost of these so-called additions to, and betterments of, the road and equipment among the Assets in the General Balance Sheet, and thereby avoid off-setting such payments by a rather obscure item on the Liability side of the Balance Sheet as the accounting rules require.

An accounting system may be correct in theory, so far as operating expenses go, when it provides for operating, maintenance, replacement in kind, and depreciation charges, and requires all beyond these charges to be considered as an addition to or betterment of the property to be shown as a capital asset. Practically this is not the case, because it does not provide a reserve against shrinkages in tariff rates, the trend of which as always been in that direction; business depressions; increased taxes and other Govermental charges; the greater cost of material and labor; or for contingencies based on sound business jugdment and pratices. Practical consideration of all these elements dictates that adequate charges to expenses for maintenance, operation, replacement, and depreciation, must be supplemented by the use of surplus income for such additions and betterments to the property, which do not materially increase the revenues of the railway, materially reduce its operating and maintenance expenses, or substantially add to the value of the property as a whole. Such expenditures should not enter into the Balance Sheet as part of the capital assets, but such part thereof as may be non-productive should be charged off to the total operating and maintenance expenses, before showing the net revenue from transportion operations; such charges to be clearly shown in the accounts so as not to impair the integrity of the operating statistics.

There now remain for examination the mouthly reports (see appendix B).

g) Monthly reports for the Government.

Each report requires a statement of Operating Revenues from Rail Operations, divided between Freight. Passenger, Other Transportation and Non-Transportation;

Operating Expenses for Rail Operations, divided between Maintenance of Way and Structures, Maintenance of Equipment, Transportation Expenses, Traffic Expenses, and General Expenses; Net Operating Revenue (or Deficit) from Rail Operations; Total Revenues, Expenses and Net Revenue (or Deficit) from Outside Operations. One twelfth of Annual Taxes is deducted from the Total Net Revenue, leaving the Operating Income. The number of miles operated on the last day of the month for which the report is made is also required to be shown. The above information is given for the month and for the period since last annual report, compared with similar month and period of previous year.

The information and statistics contained in the respective monthly and annual recort of the railways are compiled by the Interstate Commerce Commission and made the basis of its annual report to the United States Government, which is admirable in its scope and the value of the information conveyed. The Commission has recently established the issue of a monthly report giving the operating results for each system, and a summary for the entire country.

h) Governmental Purposes in Promulgating Uniform Accounting.

The objects, so far as it is possible to ascertain them, sought to be accomplished by the Interstate Commerce Commission in promulgating a uniform statement of accounts were firstly to insure the statement of revenues and expenses of the railroads on a uniform and comprehensive basis, and by monthly reports, special reports and annual reports keep investors, railroad patrons, shippers, traders, and the governmental authorities in possession of the facts; secondly, to exclude from operating expenses the cost of all additions and betterments and carry the same into the General Balance Sheet as part of the cost of the railway or its equipment and at the same time insure the inclusion of all proper charges in operating expenses; thirdly, to satisfy, amid the widespread discussion of rates and the general demand for a flat two-cent rate per mile for passenger traffic, the desire for a uniform system of accounting to campare and separate operating costs, the assumption being that after a reasonable return was paid upon the amount invested in the railroads, or upon a valuation thereof, railroads could be forced by legislative action to lower rates, and that the question of rates was inseparably connected with the cost of each service rendered; fourthly, that the use of railroad bonds as security for the issue of emergency currency in time of stringency might be permitted, provided the Government were in possession of all of the facts regarding the railroads; fifthly, to have the facts regarding railroad revenues and expenses stated in a uniform official method for use in the arbitration of labour disputes; sixthly, so that the practice of governmental regulation through the agency of the Interstate Commerce Commission and uniform accounting directed by that Commission and enforced, if necessary, by periodical examinations by its agents and examiners, would lead to administrative supervision of the railroads as a business affecting the public interest, and for that reason should be controlled.

It is not quite clear to me how that control can be justly and properly exercised

without the responsability attaching to ownership and without conflict with the powers as well as the constitutions and laws of the independent and sovereign States, under which the railroad corporations are created. To realize these objects would further require that, instead of following the constitutional method of reaching judicial conclusions respecting railroads through the courts of law, the Interstate Commerce Commission should be given judicial and inquisitorial, as well as administrative powers. Government by Commission has not yet been sufficiently tested in America to enable one to speak with certainty of the results, nor have the Commissions yet reached the extent of the powers that will doubtless be conferred upon them, but whatever may be the final result — government control or administrative supervision, or what other term may be used — uniform accounting is here to stay, and the few creases that now exist in the structure will be ironed out in good time by the Interstate Commerce Commission and the railways, and no doubt the Commissions of the various States will concur in the final action.

Canadian and Mexican Railways.

i) Uniform accounting and statistics.

The record of what has beeen accomplished in uniform accounting in North America would not be complete without including the Dominion of Canada, which has 24,104 miles of railway in operation, and while in relation to its area it has the smallest, yet in proportion to its population it has the largest railway mileage of any country in the world. These lines carry in a year 33,000,000 passengers which travel an average of 64 miles; 67,000,000 tons of freight, the average haul per ton being 197 miles. The products of agriculture, animals, mines and forests transported in bulk and at low rates, made up 75 per cent of the total freight tonnage. The revenues for the year ending June, 1909, were $145 millions, Operating Expenses, $104,000,000. Of the gross earnings 66 per cent were derived from freight, while the United States Railways derived 69 per cent from freight traffic; Great Britain, 50 per cent; France, 53 per cent and Germany, 65 per cent.

In Canada, the history of railway extension is similar to that of the United States as a great factor in developing the country and as an indispensable agency in populating its extensive area and placing its products in the proper market. The Dominion Government, the Provinces and the municipalities recognized the necessity for adequate transportation facilities and liberally encouraged railways, and Canada is now deriving the benefit of this bounty and it will be a continuously increasing benefit, for that country is yet in the infancy of its agricultural and mineral development.

For over thirty years, no uniform classification of railway accounts existed and comparisons were not possible either between its own railways or those of any other country. In 1907, a uniform accounting system was established and the reporter for America is fortunate in being able to say that with one important exception, *viz* : the inclusion in operating expenses of depreciation, the Canadian form and classifications are uniform with those of the United States. In lieu of

depreciation of course a proper replacement charge is included in operating expenses, and until a more extended practical experience with depreciation has been had in the United States it cannot be said that the Canadian method is excelled. This uniformity must have a material bearing on the relations between the two countries, because nearly all of the larger Canadian lines extend into the United States, while about twenty United States railways are operating in Canada. The Dominion report compiled by the Comptroller of Railway Statistics and made by the Minister of Railways and Canals to the Governor General, states that it took three years to make the system complete — the first to lay the foundation, the second to build the superstructure, and in 1909, the edifice assumed a definite shape.

Therefore, there are railways agregating 257,000 miles in length, working under a uniform classification of accounts and statistics, which could very properly be designated the American Uniform System, in the territory extending north of the Twenty-sixth parallel of latitude and lying between the Atlantic and Pacific oceans, embracing adverse and diverse physical and climatic features, ranging from snow-capped mountain ranges to marshy plains or parched prairies, from tropical to arctic temperatures, with just as varied temperaments of the peoples by whom it is populated in congested cities and scattering settlements. These railways serve a population numbering about 95,000,000; have gross earnings of $2,640,000,000 per annum, expend $1,855,000,000 per annum for operating expenses carry an annual tonnage of 1,600,000,000 tons, with a tonnage mileage of 231,543,000,000 miles, and 923,000,000 passengers travelling in the aggregate 31,116,000,000 miles in one year, and employ 1,584,000 persons. Although a uniform system is promulgated respectively by the national governments of the United States and Canada and in substance by the State governments and Provinces, railway officers will remember that almost in its entirety it is a definite evolution of the study and experience of over forty years of the various railway lines, discussed with, and later adopted by, the governmental bodies with the advice and assistance of railway officers.

So far as Mexico is concerned, a great part of its railway mileage, although originally constructed by private companies, is now owned by the Government, and there are many lines constructed and operated by private companies under concessions by which, at the close of 99 years, the Government takes possession, free of cost, except for the rolling stock which is valued and purchased. No uniform accounting system exists. Generally speaking, the railways follow the system devised by the Country furnishing the capital, modified to suit local conditions. The English capitalists prefer the English system modified by chartered accountants, and the American capitalists, the system used in the United States prior to its revision since 1906, and with the growth of the country it will doubtless be improved.

North American Railway Accounting.

Enough has been said as to broad features of the Uniform Classification and Accounting System, and the requirements to satisfy the governing bodies, and I may

now proceed to railway practice for the use of stockholders and the management.

The railway systems of North America, and I refer to Canada as well as to the United States, endeavour to have the accounts and statistics convey a clear and comprehensive idea of their physical and financial condition, so that heretofore or at present, no corporate or partnership undertakings in this country give to their owners and the authorities more useful or conclusive information. This is done, firstly, through the medium of the annual and monthly reports furnished to the National and State Governments, as previously stated, secondly, by their own published monthly reports of earnings and expenses, and the annual reports of the Board of Directors to the stockholders, also to the various Stock Exchanges which require full reports of the company's affairs before securities will be listed by them and under their rules an annual report to the stockholders must be issued in advance of the annual meeting.

Therefore all safeguards that arise from publicity are enjoyed to the fullest extent by the railways, the investors, the public generally, and the authorities.

j) Annual Reports and Statistics for Stockholders.

While the forms and the contents of the Annual Reports to stockholders differ radically, because each Railway Company deals with its own particular conditions, the statistics and accounts are compiled under uniform rules. The principal features are the Income Account, showing what has transpired in the way of current receipts and expenditures during the year compared with the previous year, and a General Balance Sheet, which shows the status of all accounts at the end of the year. These have always been shown by all Companies, and as the Income Account is the most important index of what has happened during the year, a typical form thereof is given below.

	1909.	Comparison with 1908. Increase or Decrease.
GROSS REVENUE		
Freight revenue		
Passenger revenue		
Mail revenue		
Express revenue		
Other transportation revenue		
Non-transportation revenue		
Total		
Expenses :		
Maintenance of way and structures		
Maintenance of equipment		
Traffic		
Transportation		
General		
OPERATING EXPENSES, EXCLUDING TAXES		
TAXES		
OPERATING EXPENSES, INCLUDING TAXES		
NET REVENUE from operation		
Deduct : Rentals paid roads operated on basis of net revenue		
NET OPERATING REVENUE		
To which add : OTHER INCOME		
Interest from investments		
Hire of equipment		
Interest General Account		
Rents		
GROSS INCOME		
Deduct payments :		
Fixed rentals of leased roads		
Interest on bonded debt		
Interest on mortgages and ground-rents		
Interest Car Trusts		
Sinking Funds		
NET INCOME		
From which deduct :		
Dividends		
Appropriation for additions and betterments not properly chargeable to Capital Account		
Surplus carried to Profit and Loss Account		

In addition, nearly all of the roads give statistics of mileage and road characteristics over which the transportation service is rendered; of the equipment in which the traffic is conveyed; of the traffic carried; its mileage; train lading; train mileage; tonnage and passengers; tonnage and passenger mileage; average revenue, expenses and net revenue or loss per ton and per passenger per mile; and average revenue, expenses and net revenue or loss per freight and passenger train mile; profit and loss account, the financial returns, the investments of the Company in detail and the income therefrom, and many other useful and interesting statistics, accompanied by comparisons with the previous year which is decidedly important and by explanatory remarks of the President or Executive officers on behalf of the Directors covering the chief features in the report, and calling attention to important matters affecting the Company.

Many railroads publish elaborate statistical tables, of which the following is a sample :

Freight traffic statistics.

—	1909.	*Comparison with 1908.* *Increase or Decrease.*
Miles of road		
Freight revenue (rail)		
Per cent of total revenue		
Number of tons carried		
Number of tons carried one mile		
Average miles each ton was carried		
Number of tons carried per mile of road		
Number of tons carried one mile per mile of road		
Freight revenue per mile of road		
Freight expenses per mile of road		
Net revenue from freight per mile of road		
Average revenue per ton (cents)		
Average revenue per ton per mile (cents)		
Average cost per ton per mile (cents)		
Average number of tons in loaded car		
Average train load, tons		
Average number loaded cars in train		
Average number empty cars in train		
Revenue freight train mileage		
Revenue freight train mileage per mile of road		
Freight revenue per revenue freight train mile (cents)		
Freight expenses per revenue freight train mile (cents)		
Revenue freight locomotive mileage		
Revenue freight car mileage		

Passenger traffic statistics.

—	1909.	*Comparison with 1908.* *Increase or Decrease.*
Miles of road		
Passenger revenue (rail)		
Per cent of total revenue		
Number of passengers carried		
Number of passengers carried one mile		
Average miles each passenger was carried		
Number of passengers carried per mile of road		
Number of passengers carried one mile per mile of road		
Passenger revenue per mile of road		
Passenger expenses per mile of road		
Net revenue from passengers per mile of road		
Average revenue from each passenger (cents)		
Average revenue per passenger per mile (cents)		
Average cost per passenger per mile (cents)		
Average number of passengers per train		
Passenger train mileage		
Passenger train mileage per mile of road		
Passenger revenue per train mile (cents)		
Passenger expenses per train mile (cents)		
Passenger train revenue		
Passenger train revenue per mile of road		
Passenger train revenue per train mile (cents)		
Passenger train expenses per train mile (cents)		
Revenue passenger locomotive mileage		
Revenue passenger car mileage		

Revenue and expenses per mile of road.*

—	1909.	*Comparison with 1908.* *Increase or Decrease.*
Gross revenue per mile of road		
Operating expenses per mile of road		
Net revenue per mile of road		

Note. — Passenger expenses include charges specially appertaining to that traffic, and also such proportion of the common expenses as its revenue train mileage bears to the total mileage, after charging against Mail and Express revenue their proportion of such common expenses.

Train mile revenue includes revenue from Mail and Express traffic.

Taxes are included in Expenses in computing above statistics.

*Per mile of track is also used.

It is the custom of the larger systems to issue these annual reports in advance of the annual meetings of the Company and as far as practicable to publish synopses thereof in the daily or financial papers so that stockholders before attending the meeting fully understand the Company's condition, have an opportunity to request further information from the management in order to intelligently decide whether their shares will be voted in support of, or in opposition to the management.

I will now pass on to the second part of the subject, *viz.*:

Operating expenses.

k) Uniform classification.

The uniform classification of operating expenses — rather than remain content with merely referring to tables 30 and 32 — Appendix A, and I will also refer to those statistics of railway operation which are taken daily, weekly and monthly, and form the basis for the reports and statistics already referred to, and are the means of directing the attention of the division operating and traffic officers to the results of operating revenues, costs and the extent of the traffic that is being moved, and to strengthen and guide the efforts of the executive officers and management in producing greater efficiency and formulating the policy of the Company.

So much has been well said and written regarding Operating Expenses that I cannot hope to impart any great freshness to the subject. The principles underlying their classification have been understood for many years and were observed by the railways to cover their particular needs in controlling their expenses, but only since 1906 were their needs adjusted to a uniform basis. Again I must extol our necessities beyond our virtues, because the perceptions of railroad men have been quickenedly, firstly, by following the uniform classification and agreeing in its revisions from time to time; secondly, by legislation enacted in a large number of States attempting, irrespective of conditions, to fix the maximum passenger fare at two cents per mile, resulting in extended legal proceedings in which the demonstrationn of the cost of passenger service and a reasonable return on the investment in the passenger business became prime factors. So far as the freight traffic is concerned, the question of rate modifications has been, and is, like the poor — ever with us, and prior to 1906 a greater advance has been made in that branch of the service than in the passenger business regarding questions of cost and average results, but honors are now about even. Thirdly, by the suggested adjustments in the compensation for transporting the mails resulting in a like study for that traffic.

Lastly, I must not forget financial and business depressions which cause all new construction work to be discontinued, and focus the attention of the executives and officers on the curtailment of operating expenses. This has been the situation since the Autumn of 1907 when the railways which had been enjoying a very heavy traffic and had spent considerable sums in increasing their tracks and facilities, suddenly found the pressure of yards crowded with loaded cars changed to one of finding siding room for the storage of empty cars. Since then, the railroad profession has had an opportunity amid the general discussion of accounts with the

Interstate Commerce Commission, rate proceedings before the various State Commissions, and the decrease in traffic, to devote considerable time to the question of a thorough study of operating expenses and operating costs. An undoubted advantage was thereby gained, resulting in a keener effort for greater efficiency in traffic movement, and in further operating economies (aside from wages and material prices), which have not yet reached their limit.

The classification of Operating Revenues as hereinbefore stated is divided into two general accounts: 1° Revenue from Transportation, and 2° Revenues from Operations other than Transportation. The former is sub-divided into eleven primary accounts and the latter which consists of station and train vending privileges, car service, news stand and parcel room receipts, etc., into eight primary accounts. See table 22, appendix A. Operating revenues are finally summarized under four heads. The following percentages in the United States indicate their relative importance for the year ending 30 June 1909 :

Freight Revenue	68·88 per cent.
Passenger Revenue	23·09 — —
Express, Mail, and other Transportation Revenue	7·11 —
Non-Transportation Revenue	0·92 — —

Railway operating expenses are uniformly classified into five general accounts: 1° Maintenance of Way and Structures; 2° Maintenance of Equipment; 3° Transportation Expenses; 4° Traffic Expenses; and 5° General Expenses.

For the year ending 30 June 1909, these expenses required 66·12 per cent of the gross revenue, compared with 69·67 per cent for the previous year, exclusive of taxes. Taxes, however, should be included, in expenses as a separate item, for while a Company and its management and stockholders can exercise supervision over its expenses and fixed charges, and determine to a large measure what they shall be, it has not the same privilege with regard to Taxes, which constitute a lien having precedence over interest on bonds and other obligatory charges, and is a primary expense that must be met before reaching the true net Operating Revenue. In the year mentioned taxes exceeded $89,000,000 and increased the operating ratio from 66·12 to 69·76 per cent of the gross revenue.

The relative importance of the operating expenses in the United States will be indicated in the following percentages of the total operating revenues and the total operating expenses which they required in the year ended 30 June, 1909 :

	Percentage of Operating Revenues.	Percentage of Operating Expenses.
Maintenance of Way and Structures	12 74 per cent	19·27 per cent.
Maintenance of Equipment	15 03 — —	22·72 —
Transportation Expenses	33 73 — —	51·01 - —
Traffic Expenses	2 02	3 06
General Expenses	2·60 — -	3·94 - -

There are other substantial expenses, known as fixed charges, and while not a part of the operating expenses, the results of railway operations cannot be considered as conclusive without keeping them in mind. I refer to interest on funded debt, other obligatory charges, and what must precede them all—taxes, for with the growth of the United States and the extravagance in municipal, state and federal government expenditures, they all are increasing year after year, without any regard to railroad expenses or revenues. The necessity, therefore, of limiting capital expenditures is a duty that the management is obliged to urge upon all departments so that every such expenditure may be made with a definite result in view, either of adding to the company's revenues, materially decreasing its operating expenses, or maintaining its progress and supremacy in its own territory.

Of the operating expenses above indicated, the General Expenses, Traffic Expenses, and probably 40 per cent of the Maintenance of Way and Structures expenses and a similar proportion of the Maintenance of Equipment expenses are constant, and must continue irrespective of the density of the traffic which is to be moved. But 70 or 75 per cent of the Transportation expenses, and at least 60 per cent of Maintenance of Way and Structures and Equipment Maintenance expenses are directly related to, and caused by, train movement.

General Expenses are divided into the following primary accounts, which fully indicate their scope :

Salaries and Expenses of General Officers.
Salaries and Expenses of Clerks and Attendants.
General Office Supplies and Expenses.
Law Expenses.
Insurance.
Relief Department Expenses fort the conduct of Employes' Sickness, Accident, and Death Benefit Funds.
Pensions.
Stationery and Printing.
Other Expenses.
General Administration Joint Tracks, Yards, and Terminals—Dr.
General Administration Joint Tracks, Yards, and Terminals—Cr.

Traffic Expenses, consisting of expenses for obtaining traffic are divided into the following primary accounts :

Superintendence.
Outside Agencies.
Advertising.
Traffic Associations.
Fast Freight Lines.
Industrial and Immigration Bureaus.
Stationery and Printing.
Other Expenses.

This brings us to what is regarded as the real operating expenses of the road, for the maintenance of the railway and structures, for maintenance of equipment, and for transportation expenses, *i. e.*, those connected with train movement. Maintenance of Way and Structures Expenses are divided into the following primary accounts :

Superintendence.
Ballast.
Ties.
Rails.
Other Track Material.
Roadway and Track.
Removal of Snow, Sand, and Ice.
Tunnels.

Bridges, Trestles, and Culverts.
Over and Under Grade Crossings.
Grade Crossings, Fences, Cattle Guards, and Signs.
Snow and Sand Fences and Snow-sheds.
Signals and Interlocking Plants.
Telegraph and Telephone Lines.
Electric Power Transmission.
Buildings, Fixtures, and Grounds.
Docks and Wharves.
Roadway Tools and Supplies
Injuries to Persons.
Stationery and Printing.
Other Expenses.
Maintaining Joint Tracks, Yards, and Other Facilities—Dr.
Maintaining Joint Tracks, Yards, and Other Facilities—Cr.

Expenses for Maintenance of Equipment are divided into the following primary accounts :

Superintendence.
Steam Locomotives—Repairs.
Steam Locomotives—Renewals.
Steam Locomotives—Depreciation.
Electric Locomotives—Repairs.
Electric Locomotives—Renewals.
Electric Locomotives—Depreciation.
Passenger-train Cars—Repairs.
Passenger-train Cars—Renewals.
Passenger-train Cars—Depreciation.
Freight-train Cars—Repairs.
Freight-train Cars—Renewals.
Freight-trains Cars—Depreciation.
Electric Equipment of Cars—Repairs.
Electric Equipment of Cars—Renewals.
Electric Equipment of Cars—Depreciation.
Floating Equipment—Repairs.
Floating Equipment—Renewals.
Floating Equipment—Depreciation.
Work Equipment—Repairs.
Work Equipment—Renewals.
Work Equipment—Depreciation.
Shop Machinery and Tools.
Power Plant Equipment.
Injuries to Persons.
Stationery and Printing.
Other Expenses.
Maintaining Joint Equipment at Terminals—Dr.
Maintaining Joint Equipment at Terminals—Cr.

Transportation Expenses are divided into the following primary accounts :

Superintendence.
Dispatching Trains.
Station Employes.
Weighing and Car-Service Associations
Coal and Ore Docks.
Station Supplies and Expenses.
Yard Masters and their Clerks.
Yard Conductors and Brakemen.
Yard Switch and Signal Tenders.
Yard Supplies and Expenses.
Yard Engineman.
Engine-house Expenses—Yard.
Fuel for Yard Locomotives.
Water for Yard Locomotives.
Lubricants for Yard Locomotives.
Other Supplies for Yard Locomotives.
Operating Joint Yards and Terminals—Dr.
Operating Joint Yards and Terminals—Cr.
Motormen.
Road Enginemen.
Engine-house Expenses—Road.
Fuel for Road Locomotives.
Water for Road Locomotives.
Lubricants for Road Locomotives.
Other Supplies for Road Locomotives.
Operating Power Plants.
Purchased Power.
Road Trainmen.
Train Supplies and Expenses.
Interlockers and Block and Other Signals—Operation
Crossing Flagmen and Gatemen.
Drawbridge Operation.
Clearing Wrecks.
Telegraph and Telephone—Operation.
Operating Floating Equipment.

Express Service.
Stationery and Printing.
Other Expenses
Loss and Damage, Freight.
Loss and Damage, Baggage.
Damage to Property.
Damage to Stock on Right of Way.
Injuries to Persons.
Operating Joint Tracks and Facilities—Dr.
Operating Joint Tracks and Facilities—Cr.

For their own special purposes, railroads further divide many of the primary accounts to keep a close watch upon results.

l) Watching revenues and expenses.

Railroad management, whether in the transportation, traffic, engineering, finance or accounting departments, is a profession, and the larger and well-established railways begin each year, not only with a record of what has been accomplished in the past year, but with an estimate for the current year made after consultation with the officers in charge of the various departments, covering, firstly, the revenues; secondly, a programme of maintenance and replacement expenditures to be paid out of current revenues, including therein proper depreciation charges unless sufficient replacements are currently made to make good the annual depreciation; thirdly, an approximate estimate of other operating expenses; fourthly, an estimate of what should be spent out of current revenues for betterments of and additions to the railway and its equipment, and fifthly, a list of expenditures for new railway construction equipment and real estate, chargeable to capital account. Between such capital expenditures, and the maintenance and replacement items charged in operating expenses, are the expenditures above mentioned in « fourth » for betterments and improvements which run concurrently in making renewals and which it has been the practice of conservatively-managed American roads to provide out of the Surplus Income remaining after the payment of the operating expenses, taxes, interest on funded debt, rentals, and other obligatory charges.

Such betterments and improvements provided out of surplus income, may include such items as the elimination of grade or level crossings, improvements in the grades and alignment of the railway and in the yards and terminal facilities, and equipment, improvements in the design and character of stations, bridges and other structures, when they are betterments which add nothing to the original plant other than the improvement which progress substitutes for the existing plant, or are necessary to keep the railway and equipment up to the standard fixed by the requirements of its business. These should be capitalizable because they do not substantially increase the revenues, materially reduce expenses, or add an important element of value to the property as a whole. This policy has been pursued for so many years that very few of the standard American railways could now be reproduced for the par value of their outstanding stocks and bonds, and it has been the chief means whereby the bonus stock issued used for promotion rewards in their early history (known as watered stock) have been corrected and the integrity of the capital account restored and preserved. It would be a matter of deep regret if this conservative policy should be disrupted and

such expenditures be forced into and retained in capital account by Governmental order.

As the year proceeds, the estimates above referred to are carefully supervised, and additions made to the construction list as the exigencies of present and future traffic demand of expenditures for branch and relief lines, extensions of terminals, yards, tracks, equipment, etc., upon the recommendation of the responsible officer in charge of that branch of the service, and appropriations are voted therefor by the Board of Directors, or other proper Committee or Executive officer.

With the question of expenditures for new railway lines, facilities, and rolling stock definitely and prudently decided, taking into consideration not only present but future requirements, for a railroad is a permanent institution, to produce and sell a product called "transportation," the duty of efficient management is first devoted to the quantity of traffic, its movement and the revenues therefrom, and the cost of its conduct—its operating expenses.

It is the duty of the compiler of statistics to separate the different classes of traffic carried and ascertain, as far as it is possible to do so, whether the service is rendered at a profit of a loss. The railroads are, of course, obliged to continue various train service especially for passenger traffic, and also to carry many items of freight traffic, which on the face of the returns cannot earn enough to pay either their share of the maintenance and operating expenses and other obligatory charges, or their part of the dividend, and must look to the more profitable items for recompense, so that rates are necessarily made on the value of the service rendered and the risk assumed, and not on the cost of transporting each commodity and the classes of passenger traffic. The railways have separated cost to the extent of over two-thirds of their total expenditures between the passenger and freight traffic, respectively, but one-third of the cost, made up of items like maintenance of way, is common to both passenger and freight traffic, and also the taxes, interest on the investment, etc. These common costs have been divided largely on the basis of train mileage, as being the most convenient and, weighing all past and present practical conditions, is perhaps the most acceptable method, although locomotive and car mileage are used by some roads.

The end of this cost accounting will not be reached until the return and cost of every service rendered for both passenger and freight traffic is resolved into units of lading and distance, reflecting the use that has been made of the equipment, and the service rendered on each of the larger Divisions or sections of the railway, and comparisons made with previous years. The railways no longer consist of short lines of single track which in the earlier days could be supervised by a single officer and a small staff, but of large systems with great stretches of four-track lines. These require for their opeartion an extensive and trained organization, and the advancement of the art has been so great, due to the provision of adequate facilities and equipment, traffic density, rate changes, and increased taxes, wages and prices of all kinds, that each branch of the railroad business is becoming specialized and the question of costs and net results in

reaching the stage of a highly-organized industry.

The day of general facts and individual preference in recording results is past, and statistics that fully tell the story, and will bear the light of comparison must be kept to justify the efficiency of the operating officer, whose value is demonstrated by the facility and economy with which the traffic is moved, under the particular or peculiar conditions applying in the part of the railway under his supervision, and the operating plant, consisting of the road, stations, shops and equipment, is maintained and operated.

Those lines with which I am most familiar operate the railway by separating it into divisions, each in charge of a Division Superintendent, having full authority, and responsible to a General Superintendent, who supervises several divisions, and who in turn is responsible to the General Manager and the latter to the Executive officers. There are, of course, many companies which pursue a different plan of organization, and effect results by different methods and different officers from what I describe.

The three branches of the service — Maintenance of Way, Maintenance of Equipment (rolling stock), and Transportation (train movement) — is confided for results to a Division Superintendent having anywhere from 150 to 250 miles of main railway mileage, with branches, or a total track mileage, exclusive of sidings, of from 500 to 750 miles, depending on the traffic density and the district served. Having the largest share of the operating expenses, the operating branch of the service is at all times subject to the greatest crossfire.

This quickened responsibility led to a demand that operating statistics and costs which formerly were compiled in copperplate fashion after the close of the month, should be promptly furnished so that defects could be remedied, for the results of train, car and tonnage movement and costs must reach the man in charge promptly after the train movement occurs, otherwise a railroad in operation may soon deplete its revenues by the heavy expenditures for labour and materials, for unremunerative train and car mileage, and unless the cause is very marked, and the inquiry promptly follows the cause, the management can obtain only a general explanation for bad operating results, instead of the conservation of its funds. Taking the experience in 1907 as an illustration when conditions changed from high water mark of traffic in the beginning of the year to a business depression in the latter part of the year, the operating officer could not immediately decide exactly where and what expenses should be immediately reduced without facts promptly furnished to supplement his judgment. It therefore became a matter for decision as to what statistics were required to give a division officer adequate and prompt control of the situation and to have his expenses well in control.

The Maintenance of Way and Structures and Maintenance of Equipment Expenses, amounting to 42 per cent of the total expenses, are governed, first, by the definite programme allowances made at the beginning of the year, and these or the other programme allowances mentioned are not exceeded except for special purposes approved by the Chief Executive officer in charge of operations, and, if of sufficient

importance and not the ordinary and necessary expenses for upkeep, require approval by the President and the Board. These programme estimates are based on and compared with, similar expenses and costs of previous years on various bases, so that any unusual features of increases or decrease must be fully explained, before being authorized. The changes in Division Superintendents or other officers on a large and active railroad give a fresh view of this question at least every few years. The division or other officer must make his programme estimates based on personal knowledge and on the information given him by his staff, composed of men trained in each branch of the service, and they are subsequently subjected to the scrutiny of the General Superintendent, and, in the case of Maintenance of Equipment Expenses, to that of the respective Superintendents of Motive Power, the General Superintendent of Motive Power, or other proper officer in charge of motive power, and in the case of Maintenance of Way and Structures Expenses, to the Chief Engineer of Maintenance of Way, and finally all such reports are scrutinized by the General Manager. It is clear that after so many trained men have given their experience it is difficult to go far astray in a proper annual expenditure, especially as after its authorization its outgo is carafully guarded, and is subject to the orders of the Division Officer or his responsible assistants in charge of railway and structures, and in charge of the equipment handled in the shops. There is also included as part of the maintenance and operating expenditures a charge to provide for the replacement of the equipment.

So far as expenses for maintenance of tracks, bridges, stations and structures, and maintenance of equipment are concerned, which amount to about 42 per cent of the total operating expenses, they necessarily are related to the extent of the train service, yet in business decreases and does not justify it, a very large part can be deferred, provided the railway and equipment has been heretofore maintained in good working condition and repair.

Little credit has therefore in the past been given for reducing Maintenance of Way or Equipment Expenses because it has been the favourite method of "skimping the property," whereas reduction in Transportation (Train Movement) Expenses is regarded as an indication of efficient management, but now that all expenses are shown in detail in the railway reports and comparison with the previous year, one is enabled to locate the items in which the saving has been effected and prove to a certainty that such has been the case, so that the old time charge of "skimping the property" by neglecting or deferring maintenance or other expenses can no longer be made unless proven by actual results.

In Transportation Expenses, which amount to 51 per cent of the total operating expenses and are so largely dependent upon the train movement, costs of labor and supplies, and traffic density, it is more difficult to effect economies without the closet supervision. In this branch of the service, it is very clear that results must promptly be in the hands of the Superintendent, or labour costs, improper train loading, slow movement, and excessivemileage will seriously interfere with the results. All of this means

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close watching and the necessity of quickly obtaining unit figures as a warning and comparison.

Since two-thirds of the revenue of the American Railways arises from freight traffic, it is not surprising to find that so much attention is directed to operations in that service. The proper officers with their staff officers and others concerned, have constantly before them telegraphic reports of yard and road conditions; also reports for slow freight trains, showing the number of trains, number of cars, gross lading of each car, train mileage, running times between terminals, average speed, gross ton mileage, *i. e.*, weight of car plus lading, and also the potential ton mileage, which in effect is the maximum which the engine could have hauled under ideal conditions. This is given for comparison with actual gross ton mileage as regards efficiency. As there are many fast freight trains containing lading of a perishable nature which must be run at a fast speed, independent of lading and other conditions, he also has a statement of the gross ton miles of all freight trains and the car mileage, loaded and empty, and the total, and percentage of, loaded and empty cars.

The greatest attention is paid to the lading of the trains so that economical movement may be made and payment of overtime and other expenses avoided. The daily report of the movement of loaded and empty cars past junction or other strategic points, where trains mass in reaching a terminal, showing comparisons with similar previous periods, gives one of the first clues to the business of the day and is about the quickest statistic telegraphed; then comes the weekly return of revenues, divided between freight, passenger, mail and express traffic, the freight often being divided between general merchandise and mineral traffic, and for many roads this weekly information, although approximate, is published in the newspapers. Passenger train lading and results are closely watched, and the Superintendent keeps in close touch with their movement and car mileage. Further, for passenger trains, it is the custom with many roads to take the earnings of each train as often during the month as necessary to insure reliable results and use them in reaching conclusions as to whether trains should be removed or the service supplemented. A statement is furnished monthly of tonnage of principal commodities moved on the divisions. The monthly income account of revenues and expenses for each company and each division, and summarized for the company as a whole, and with the necessary addition of other Income and the deduction of fixed charges and other obligatory payments, gives the first idea of total net income compared with the same month and with a similar period of the previous year. Statistics of cars, tons and passengers moved from the principal stations; statistics of tonnage and passenger mileage, including the average rates, costs and profit or loss per mile from each ton and passenger; and the earnings, expenses and net revenue or loss per train mile. All of these statements are made up by divisions and comparisons and explanations required of the various increases or decreases.

This information at the close of each mont in the hands of each operating official resolves itself down to the following

facts compared with the same month in the previous years : Number of locomotives in service of various kinds and the percentage in good condition, locomotive mileage of all kinds, average locomotive mileage in the various branches of service, average mileage between shoppings for repairs during the month and the two months preceding; passenger car mileage, average number of cars per passenger train, passenger train detentions due to locomotive failures or car failures; freight car mileage, east, west, north and south, loaded and empty, and the percentage of both; average number of cars per freight train; total gross ton mileage; average gross ton per freight train and per freight car; ton mileage; average speed; percentage of passengers and freight trains on time.

The above statement does not require the compilation of operating costs, but closely following same is required a statement of operating costs, worked out upon the following basis :

Coal consumption; consumption of waste and lubricating material; cost of certain passenger (based on 1,000 passenger car miles) and freight (based en 1,000,000 gross ton miles), expenses, including coal for locomotives, wages of enginemen, firemen and trainmen, and supplies furnished trainmen. Cost of certain yard expenses (based on each 1,000 cars dispatched from the yard), including yard locomotives, wages of enginemen, firemen, conductors and brakemen, supplies (except for enginemen and firemen), yard-masters and their clerks, yard switching and signal tenders. Cost of locomotive supplies furnished enginemen and firemen per locomotive in service; engine house expenses per locomotive handled; locomotive repairs per 100 locomotive miles. General movement expenses per 100 locomotive miles, covering lubrication, water, fuel, and other supplies for road locomotives, repairs, renewals and depreciation of road locomotives, engine-house expenses for road locomotives, road enginemen and trainmen. train supplies and expenses.

As this information covers matters controlled largely by the several Division Superintendents and their staff officers, and is compiled in the early part of the month following that in which the expense was incurred, with the approximate expenditures for labour and material, the remedy is largely first in their own hands, but does not remain there, for the higher operating officers are subsequently furnished with the same information arranged to suit their purposes, and explanations as to good or bad results are demanded. The management further exercises its influence on expenditures dependent on many other conditions, such as the present or anticipated financial and industrial conditions. The results of each month's workings of the respective divisions, including all charges whether entirely under the Superintendent's control or not, are sent to the Superintendent and other proper officers of the operating and traffic departments to arouse their responsibility and encourage their efforts to obtain more business, or greater promptness and economy in the movement of the business on the line, and to earn their proper proportion of the fixed charges, dividends that should be paid, and amounts that should be provided for betterments out of income. Is is essential that the statistics of costs to be

put in possession of a Divisional operating officer should first be those over which he has control, that they may apply proper remedies for unsatisfactory performances brought to light by equitable comparisons, but such officers should not be allowed to forget that other charges, such as taxes and interest exist, which are not chargeable to expenses, and that dividends should be earned and paid. Statements of the unit costs of handling tonnage, passengers and baggage at the larger stations are also prepared and sent for criticism to the various officers, and to ascertain why costs are higher or lower at one station than another. On some railways, the chief features of expenditures are also exhibited by chart and diagrams so that vivid pictures as well as figures may drive home the facts. There are now on several of the operating staffs, officers who are charged with the duty of supervising operating costs of all kinds including shop results, and to ascertain by personal examination and conference why better results cannot be obtained, and create a wholesome spirit of emulation among the various officers and divisions to bring about these results. I do not wish to convey the impression that all the railways in the country compile and use all of the foregoing facts, or that the American Railway officer spends the most of his time sitting at a desk, wearing a pair of spectacles, digesting railway statistics, or has any greater love for them than officers in other countries, but in so far as they are of assistance to him, he must, and does, study railway statistics. Constant and personal familiarity with his operating, division, or departmental work, with the assistance of a trained staff, enables him to discern promptly any danger signal of loss of business or excessive cost. As the result of an evolution in a chain of progress of which he is a part, he must and does, profit by statistics, and improves the situation by direct and immediate action taken on the ground as the result of his consideration, or if he cannot do so, is in a position to report to his superior officer reasons for such inability and receives the results of the more extended experience of the latter, who will also probably warn other officers.

I make no reference to the large number of reports concerning the daily operating routine and management because they have become standard, and relate to different features of the railway, ties, rails, its equipment, supplies, shops, signals, and interlocking, tests of all kinds; or to the special studies as new problems arise. These are all taken for granted as being necessary in every country.

The statistics and other information furnished by the officers, agents and employes of each division must be such so that when supplemented by the fixed charges and other obligatory payments and dividends disbursed, the Comptroller, Auditor, or General Accounting Officer may compile thereform the respective monthly and annual reports to the stockholders and to the National and State authorities, and must comprehend the statistics hereinbefore indicated.

Conclusions.

I need not advocate the necessity or advantages of a uniform system of accounts or statistics, for that is behind the railroads in North America, which are devoting their energies to settling the few

remaining points in connection with the prescribed accounts, in such a way as to make the system finally effective and adapted to the varying interests of the weak as well as the strong roads, and to those Compagnies which must observe special charter requirements of the States or Provinces in which they are incorporated. That such advancement has been made is not due to any inherent virtue in American Railway management, but rather to the necessities of development and management already alluded to, which were stronger than any inherent inclinations.

The experience of American railways removes all doubt as to the results achieved by vital statistics, in the hands of those directing and operating the various lines. Rates have fallen, operating expenses, taxes and other charges increased, but the growth of traffic has been handled with greater economy because the operating and traffic officers had full statistics for their constant reference and warning, and these statistics were available for use in various forms very soon after the traffic was moved or the expense incurred. The remedies have been applied in the shape of larger cars, larger train loads, and cars constructed of more durable materials, larger and more scientifically designed freight classification yards and facilities, and the use of a large part of the surplus income for improvements of the grades, alignments and facilities, thereby restricting capital charges and making dividends a permanent feature by deferring them until the condition of the railway and its equipment justified their payment.

In stating these facts, I do not lay claim to any superiority for American methods, nor am I oblivious to the progress in accounting and statistics made by the Railways of other countries, from which we may learn a great deal.

The railroads in North America have by consolidation and affiliations developed into large systems, each embracing from a few thousand to several thousand miles of main running tracks, so that it is impossible to manage them efficiently without the assistance of vital and comprehensive accounts and statistics of the service performed, the volume and character of the business done, the revenues, costs, and net revenues therefrom, and comparisons with other periods compiled in such a way as to aid the efficient direction and management of the property, by quickening responsibility from the highest to the lowest, and from the lowest to the highest officer. In America, there is less time and no more money to be wasted on statistics, unless useful, than in any other part of the world.

a) I take the broad ground, and from the list her ein stated it will be conclusive that no special statistic is believed to tell the whole story without others to supplement and correct it. All statistics kept should demonstrate their utility, and if not demonstrated should be abandoned. Scarcely any two officers derive a like value from a similar statistical statement because of their personal characteristics and service in which they received their training, or because the traffic or problems of their respective divisions differ radically. *b*) No matter what statistics are prepared, it will always require : 1° personal knowledge of the road, its traffic, working conditions all standards to properly interpret them, so that they will act as a guide to, and quicken that responsibility which

results in efficient operating results, and 2° men of ability, experience and loyalty to produce such results. These results cannot now-a-days be achieved until the sense of responsibility and some sort of comparative costs and results are given to foremen, section men, station-masters, yard-masters, agents and train-masters, as well as officers, so as to give them facts covering the cost of labour and supplies involved in their own work, and gradually interest them towards greater efficiency by eliminating waste of materials, time, and effort. This field is still a large and fruitful one, and the costs involved are too large to take chances on results; *c*) Unless statistics reach operating, traffic, and administrative officers within a relatively short time after the operations have taken place, their value is largely lost, and they then serve purposes of record only. This can only be done without duplicating working forces, by the close working of the operating and auditing officiers; *d*) Each operating and traffic officer should have one or two recognized daily statistics summarized by weeks and for the month, agreed upon with the auditing officers, depending upon the character of the division (*i. e.*, whether it is one fed by traffic from other divisions, or is a division located in strictly competitive territory where traffic originates, or has other special features), to keep him in touch with actual operating conditions upon his division affecting operating efficiency and costs. The poorer the railway, the greater the necessity for knowledge of this character, and the greater the necessity for co-operation between operating traffic and accounting officers. When weekly or monthly statistics for a division are furnished, a separation should be made between the statistics, subject to the control of the operating officer from those over which he has no control, or only partial control, and a clear comparison of both sets of statistics given with a simliar month and period in the previous year. Divisional operating officers, through the medium of monthly divisional income and expense accounts, should be given the facts regarding the proportion of the fixed and other obligatory charge of the Company which the earnings of their division are expected to meet, over and above the operating and maintenance charge. The latter quickens a responsibility for earning a good margin over operating expenses, and broadens the view of the officer; *e*) a definite classification must be uniformly observed so that the statistics will at all times convey the same meaning and insure proper comparison with the same items for similar previous periods of the same road or division with itself but not necessarily, however, with those of any other railroad; *f*) that railway revenues and expenses be absolutely separated from all other operations which the company conducts or in which it is interested; *g*) that in no system of uniform accounting should the desire for special information by Railway or Government officials lead them to make arbitrary decisions which strip the operating expenses of everything except bare maintenance charges, and force all above that into the capital accounts. In the interest of the public and the railways the capital accounts should be limited as much as possible, and every encouragement give to make adequate charges to expenses, since all transportation officers naturally try to keep their expenses down rather than up, and so prove their supe-

rior operating methods. Charges in excess of ordinary maintenance can be so shown in the accounts that uniformity will not be outraged. In the desire to standardize accounts, the efforts should be confined to principles and not to details of management, for it must be remembered that each railroad is a problem, and any attempt to mould all railroads to one pattern will eventually be found ill-advised on the part of the regulator, hurtful to the regulated, and an incubuson individual and corporate effiency; *h*) while the American accounting and statistical system is not absolutely perfect, I do not know that it is excelled anywhere. It has proved its benefit to the railroads, and enables investments in railroad securities to be made on a clear knowledge of the physical and financial conditions of the companies.

The railways and their transportation services are deemed to be of a public nature, because the State confers upon them the power to condemn and appropriate land for their purposes subject to the payment of the proper value therefor, and because of the dependence of the community upon the transportation service. So far as the right of eminent domain is concerned, the railways avail themselves of it only as a last resort, after exhausting private negotiations, because of the excessive prices awarded by court juries or commissioners compared with the actual value of the land, but although the railway are privately owned, they are nevertheless granted this right because the use of the land is for the public benefit. The real reasons why the railways are a public benefit are because 1° they enrich the landowner from whom the right of way must be purchased; 2° they create wealth for the State, municipalities, and country through which the lines are constructed by furnishing the means for the development of natural resources, manufactures, and other commodities, quickly and cheaply bring them to the proper market; 3° they increase the revenues of thecommunity by liberal payments of taxes; 4° they constantly enlarge and improve their facilities; 5° they precede instead of follow the settler, thereby stimulating population and greatly extending and serving the wants of the community as well as adding to the ability by which such wants or luxuries are supplied and satisfied; 6° they furnish a reliable avenue for investments of home and foreign monies, and steady employment for large bodies of all grades of labourers, artisans, clerks and professional men; 7° and they open a large and constant market for all kinds of materials and supplies consumed over an extensive area.

Their permanence insures prosperity to the community and while other industries may come and go with only a temporary or partial effect, all suffer when the transportation service ceases or becomes insufficient.

It would be idle to deny that we are living in a new era of progress, in which the standards of living and practice have been materially improved, and railways and other transportation agencies have played no small part in disseminating these higher standards of living and intelligence throughout the world. They minister to the supply and demand of the whole world, break down the barriers of racial prejudice and provincialism, especially the railways in a country of extensive natural resources and population like North America, and nothing can permanently affect

the existence of the railways, the service they render, or the charges for such service, that is not communicated to those countries who look to it as the sources for agricultural, mineral, forestry and manufacturing products and to their citizens who have invested their capital therein.

These factors have created a demand in all countries for the standardization of railways as well as inquiries regarding their operating and financial results, and for the use of standard units by which these results may be conveyed in unmistakable form and substance. Uniformity of accounting and statistics will never admit of an actual and final comparison of one railway with another without a full knowledge of all the facts and conditions, nor will average statistics ever form a reliable a reliable rate-making basis, although in the days of keen competition these figures were a guide to that end and when uniformly kept for a series of years are a great advantage. It would nevertheless be a distinct gain to the railway profession, to those whose monies are invested therein, and to the Governments from which railway powers are derived, if this responsibility were so appreciated that a uniform system of railway reports and particularly a uniform system of operating statistics, so far as the same can be made uniform, were to be adopted by the International Railway Congress. For that purpose, and fully appreciating the difficulties of reaching a conclusion, I respectfully invite attention to the condensed classificatton of operating expenses hereto attached, marked appendix C, used in this country by many railways. It will be noticed that while this classification requires five general accounts, only 44 primary accounts are required in lieu of the 116 primary accounts in the classification for the larger systems. Sufficient experience is now at the disposal of the Congress to prove that a uniform classification of operating expenses is pratical and can by degrees be evolved by the cooperation of all countries, and the greatest benefit of all will be conferred upon the railways themselves by the publication of facts which testify to their skilfull operation and efficient management.

APPENDIX A.

Table I.

HISTORY.

1. Exact name of common carrier making this report.

2. Date of organization.

3. Under laws of what Government, State, or Territory organized? If more than one, name all; give reference to each statute and all amendments thereof.

4. If a consolidated company, name the constituent companies. Give reference to charters of each, and all amendments of same.

5. Date and authority for each consolidation.

6. If a reorganized company, give name of original corporation and refer to laws under which it was organized.

Table 2.

DIRECTORS.

NAME.	POST-OFFICE ADDRESS.	DATE OF EXPIRATION OF TERM.

PRINCIPAL OFFICERS.

TITLE.	NAME.	OFFICIAL ADDRESS.
Chairman of the Board		
President		
First Vice-President		
Second Vice-President		
Third Vice-President		
Secretary		
Treasurer		
General Solicitor		
Attorney, or General Counsel		
Comptroller		
Assistant Comptroller		
Auditor		
Assistant Auditor		
General Manager		
Assistant General Manager		
Chief Engineer		
General Superintendent		
Trafic Manager		
General Freight Agent		
General Passenger Agent		
General Ticket Agent		
Land Commissioner		

Officer to whom correspondence concerning this report should be addressed:

NAME.	TITLE.	ADDRESS.

Table 3.

TRANSPORTATION CORPORATIONS CONTROLLED BY RESPONDENT.

NAME.	Control.					
	Sole or joint.	How established.	Extent.	Direct or indirect.	If indirect, name of intermediary through which control is established.	Other parties to agreement for joint control.
Active Corporations :						

Table 4.

TRANSPORTATION CORPORATIONS CONTROLLED BY RESPONDENT. (*Concluded.*)

NAME.	Control.					
	Sole or joint.	How established.	Extent.	Direct or indirect.	If indirect, name of intermediary through which control is established.	Other parties to agreement for joint control.
Inactive Corporations :						

Table 5.

FACTS PERTAINING TO CONTROL OF RESPONDENT.

1. Date of last meeting of stockholders for election of directors.

2. Date of last closing of stock books before end of year for which this report is made.

3. Total number of stockholders at that date.

4. Has each share of stock on vote?

   If otherwise, explain voting rights.

5. Has any issue of securities contingent voting rights?

   If so, explain character of such rights.

6. Has any issue of securities special privileges in the election of directors?

   If so, explain character of such privileges.

7. Did any other corporation or corporations, transportation or other, control the respondent on June 30, 1909?

   If control was so held state:

   a) The form of control, whether sole or joint;

   b) The name of the controlling corporation or corporations;

   c) The manner in which control was established;

   d) The extent of control;

   e) Whether control was direct or indirect;

   f) The name of the intermediary through which control, if indirect, was established.

8. Dit any individual, association, or corporation, as trustee, control the respondent on June 30, 1909?

   If control was so held, give the names of the trustee and the beneficiary or beneficiaries for whom the trust was maintained.

Table 6.

ROAD OPERATED.

NAME OF EVERY RAILWAY COMPANY THE OPERATIONS OF WHICH ARE INCLUDED IN THIS REPORT.

In giving roads below, observe the following classification and order :

1. Line owned by respondent :
   A. Main line.
   B. Branches and spurs.
2. Line operated by respondent but owned by another corporation, control being secured through stock ownership.
3. Line operated under lease for specified sum.
4. Line operated under contract or agreement, or where the rent is contingent upon earnings or orther considerations.
5. Line operated under trackage rights.

Name.	Termini.		Miles of line for each road named.	Miles of line for each class of roads named.
	From :	To :		

Table 7.

1° ROAD JOINTLY OWNED OR. — 2° ROAD JOINTLY LEASED.

Name.	Termini.		Miles of line for each road named.	Miles of line included in preceding table.
	From :	To :		

Table 8.

OUTSIDE OPERATIONS AND OTHER PROPERTIES.

A. — OUTSIDE OPERATIONS.

Designation.	Character of business.	Title. (Owned, Leased, etc.)	State or territory.

B. — OTHER PROPERTIES.

Designation.	Character of business.	Title. (Owned, Leased, etc.)	State or territory.

Note. — The statements required on this table, together with the statement of railway line owned, should embrace all property covered by the capital of the respondent.

A. — Outside Operations :

In this table should be entered all properties operated by the respondent as « Outside Operations » for which separate revenue and expense accounts are submitted. A summary of these accounts should appear on table 33.

B. — Other Properties :

In this table should be entered all Government land grants, and coal, lumber, and other business properties not included in railway line owned, or in « Outside Operations ». The revenues, expenses, and taxes of these properties should be summarized on table 33.

Table 9.

ROAD ACQUIRED BY RESPONDENT FOR OPERATION THROUGH LEASE OR OTHER AGREEMENT.

NAME OF OWNING COMPANY.	Miles of line.	Lease or Agreement.		
		Date.	Term.	Concise Summary of Provisions.

ROAD ASSIGNED TO ANOTHER CARRIER FOR OPERATION THROUGH LEASE OR OTHER AGREEMENT.

NAME OF OPERATING COMPANY.	Termini.		Miles of Line.	Lease or Agreement.		
	From :	To :		Date.	Term.	Concise Summary of Provisions.

Table 10.

CAPITAL STOCK.

DESCRIPTION	Number of shares authorized.	Par value of one share.	Total par value authorized.	Total par value outstanding.	Total par value held by respondent corporation.		Total par value not held by respondent corporation.	Dividends declared during year.	
					In treasury.	In sinking or other funds.		Rate.	Amount.
Capital Stock: Common . . .									
Preferred . . .									
TOTAL. . .									

PURPOSE OF THE ISSUE .		Number of shares issued during year.	Cash realized on amount issued during year.	Total number of shares outstanding.	Total cash realized.	*Remarks.*
Issued for Cash.	Common . . .					
	Preferred. . .					
Issued for Construction of New Properties	Common . . .					
	Preferred. . .					
Issued for Additions and Betterments	Common . . .					
	Preferred. . .					
Issued for Purchase of Railway or Other Railway . .	Common . . .					
	Preferred. . .					
Issued for Acquisition of Securities	Common . . .					
	Preferred. . .					
Issued for Reorganization .	Common . . .					
	Preferred. . .					

Table 11.

FUNDED DEBT.

CLASS OF BOND OR OBLIGATION.	Term.		Total par value authorized.	Total par value outstanding	Total par value held by respondent corporation.		Total par value not held by respondent corporation.	Interest.			
	Date of Issue.	Date of Maturity.			In treasury.	In sinking or other funds.		Rate.	When payable	Amount accrued during year.	Amount paid during year.
Mortgage Bonds :											
Collateral Trust Bonds :											
Plain Bonds, Debentures, and Notes :											
Income Bonds :											
Miscellaneous Obligations :											

Table 12.

—

FUNDED DEBT. (*Continued.*)

EQUIPMENT TRUST OBLIGATIONS

A. — GENERAL STATEMENT.

Series or other designation.	Date of issue.	Term.	Number of payments.	Equipment covered.	Remarks.

B. — STATEMENT OF AMOUNT.

Series or other designation.	Cash paid on delivery of equipment,	Deferred payments.				Interest.		
		Interest.		Principal.		Amount accrued during year.	Amount paid during year,	Rate.
		Original amount.	Amount outstanding.	Original amount.	Amount outstanding			

Table 13.

RECAPITULATION OF FUNDED DEBT.

ACCOUNT.	Total par value Outstanding.	Total par value held by respondet corporation.		Total par value not held by respondent corporation.	Interest.	
		In treasury.	In sinking or other funds.		Amount accrued during year.	Amount paid during year.
Mortgage Bonds						
Collateral Trust Bonds.						
Plain Bonds, Debentures, and Notes						
Income Bonds						
Miscellaneous Obligations.						
Equipment Trust Obligations						
Total.						

PURPOSE OF THE ISSUE.	Total par value issued during the year.	Cash realized on amount issued during the year.	Total par value outstanding.	Total cash realized.	*Remarks.*
Issued for Cash :					
Issued for Construction of New Properties :					
Issued for Additions and Betterments :					
Issued for Purchase of Railway or Other Property					
Issued for Acquisition of Securities :					
Issued for Refundment of Securities :					
Issued for Reorganization :					

Table 14.

RECAPITULATION OF CAPITALIZATION.

ACCOUNT.	Total par value outstanding.	Assignment		Amount per mile of line.		*Remarks.*
		To railways.	To other properties.	Miles.	Amount.	
Capital Stock—Table 10						
Funded Debt—Table 13						
Total. . .						

RECEIVERS CERTIFICATES.

DATE ISSUED.	Amount issued.	Amount outstanding.	Principal.		Interest.		
			Amount paid during year.	Amount funded or otherwise disposed of.	Amount accrued during year.	Amount paid during year.	Rate.

CURRENT ASSETS AND LIABILITIES.

Cash and current assets available for payment of current liabilities.		Current liabilities accrued to and including june, 30, 1909.	
Cash		Receiver's Certificates	
Bills Receivable		Loans and Bills Payable	
Due from Agents		Audited Vouchers and Accounts	
Due from Solvent Companies and Individuals. . . .		Wages and Salaries	
Traffic Balances due from other Companies		Traffic Balances due to other Compagnies.	
Other Cash Assets (Excluding « Materials and Supplies ») (1). . .		Dividends not Called for.	
		Matured Interest Coupons Unpaid (Including Coupons Due July 1)	
		Rents due July 1	
		Miscellaneous	
Total : Cash and Current Assets . . .		Total : Current Liabilities. . .	
Balance : Current Liabilities. . . .		Balance : Cash Assets	
Total. . .		Total. . .	

(1) Materials and Supplies on hand, $.....

(*See General Balance Sheet Table 41.*)

Table 15.

SECURITY FOR FUNDED DEBT.

CLASS OF BOND OR OBLIGATION.	Road Mortgaged.			Amount of Mortgage per Mile of Line.	Equipment, Income, Securities and other Property Mortgaged.
	From :	To :	Miles.		

Table 16.

EXPENDITURES FOR ADDITIONS AND BETTERMENTS.

All expenditures for Additions and Betterments should be charged to one of three accounts : *a*) Capital, *b*) Special funds set aside from income, *c*, Current income : but the same expenditures must not be included in *more than one* of these accounts. In connection with entries of Additions and Betterment is should be observed that.

1. If entered in the column headed « Charged to capital » they must be further included in the column headed « Total cost to June 30, 1909 », on tables 17 and 18.

2. If entered in the column headed « Charged to special funds » they must represent expenditures charged against funds specially set aside out of current income or accumulated surplus. It should be noted that charges to « Replacement funds » are not to be reported in this column.

3. If entered in the column headed « Charged to income » their total should be carried to the Income Account on table 20 and entered as « Additions and betterments charged to income ».

ACCOUNT.	Expenditures during year.			Total.
	Charged to capital.	Charged to special funds.	Charged to income	
1. Right of Way and Station Grounds				
2. Real Estate				
3. Widening Cuts and Fills.				
4. Protection of Banks				
5. Grade Revisions and Changes of Line				
6. Tunnel Improvements				
7. Bridges, Trestles, and Culverts				
8. Increased Weight of Rail.				
9. Ballast.				
10. Additional Main Tracks				
11. Sidings and Spur Tracks.				
12. Terminal Yards.				
13. Fencing Right of Way				
14. Improvement of Over and Under Grade Crossings				
15. Track Elevation, Elimination of Grade Crossings, etc.				
16. Interlocking Apparatus				
17. Block and Other Signal Apparatus.				
18. Telegraph and Telephone Lines				
19. Station Buildings and Fixtures.				
20. Shops, Enginehouses, and Turntables				
21. Shop Machinery and Tools				
22. Water and Fuel Stations.				
23. Grain Elevators and Storage Warehouses				
24. Dock and Wharf Property				
25. Electric Light and Power Plants				
26. Electric-Power Transmission				
27. Gas-Producing Plants.				
28. Snow and Sand Fences and Snow Sheds.				
29. Miscellaneous Structures.				
30. Reconstruction of Road Purchased				
31. Equipment				
32. Interest and Commission.				

Table 17.

EXPENDITURES FOR ROAD.

The purpose of tables 17 and 18 is to show in detail 1° the expenditures during the year for new main and branch lines and extensions of existing lines; and 2° the expenditures during the year for Additions and Betterments transferred from table 16, classified in accordance with the same list of accounts. That portion of « Expenditures for new lines or extensions during year » chargeable to income should be carried to the Income Account on table 20 and entered as such under « Miscellaneous ».

ACCOUNT.	Expenditures for new lines or extensions during year.		Expenditures for additions and betterments during year. (Table 16.)		Total cost to June 30, 190[illegible].	Total cost to June 30, 1909.
	Charged to capital.	Charged to special funds or income.	Charged to capital.	Charged to special funds or income.		
I. Road :						
1. Engineering						
2. Right of Way and Station Grounds						
3. Real Estate						
4. Grading						
5. Tunnels						
6. Bridges, Trestles, and Culverts						
7. Ties						
8. Rails						
9. Frogs and Switches						
10. Track Fastenings and Other Material						
11. Ballast						
12. Track Laying and Surfacing						
13. Roadway Tools						
14. Fencing Right of Way						
15. Crossings and Signs						
16. Interlocking and Other Signal Apparatus						
17. Telegraph and Telephon Lines						
18. Station Buildings and Fixtures						
19. General Office Buildings and Fixtures						
20. Shops, Enginehouses, and Turntables						
21. Shop Machinery and Tools						
22. Water Stations						
23. Fuel Stations						
24. Grain Elevators						
25. Storage Warehouses						
26. Dock and Wharf Property						
27. Electric-Light Plants						
28. Electric-Power Plants						
29. Electric-Power Transmission						
30. Gas producing Plants						
31. Miscellaneous Structures						
32. Transportation of Men and Material						
33. Rent of Equipment						
34. Repairs of Equipment						
35. Earnings and Operating Expenses during Construction						
35½. Injuries to Persons						
36. Cost of Road Purchased						
Total.						

Table 18

EXPENDITURES FOR EQUIPMENT, GENERAL EXPENDITURES, AND RECAPITULATION.

ACCOUNT.	Expenditures for new lines or Extensions During year.		Expenditures for additions and Betterments During year. (See table 16).		Total Cost to June 30, 1908.	Total cost to June 30, 1909.
	Charged to Capital.	Charged to special Funds or income.	Charged to Capital.	Charged to special Funds or income.		
II. Equipment:						
37. Steem Locomotives						
38. Electric Locomotives						
39. Passenger-Train Cars						
40. Freight-Train Cars						
41. Work Equipment						
42 Floating Equipment						
Total						
III. General Expenditures:						
43 Law Expenses						
44. Stationery and Printing						
45. Insurance						
46. Taxes						
47. Interest and Commissions						
48. Other Expenditures						
Total						
Recapitulation.						
I. Road						
II. Equipment						
III. General Expenditures						
Total						
Cost of Road per Mile of Line						
Cost of Equipment per Mile of Line						
General Expenditures per Mile of Line						
Total per Mile of Line						

Table 19.

INCOME ACCOUNT.

Operating Income :											
Rail Operations :											
Operating Revenues—Table 22					*	*	*		*	*	*
Operating Expenses—Table 32					*	*	*		*	*	*
Net Operating Revenue. . .	*	*	*						*	*	*
Net Operating Deficit . . .	*	*	*						*	*	*
Outside Operations. (Table 33 A) :											
Revenues					*	*	*		*	*	*
Expenses					*	*	*		*	*	*
Net Revenue	*	*	*						*	*	*
Net Deficit	*	*	*						*	*	*
Total Net Revenue	*	*	*						*	*	*
Total Net Deficit	*	*	*						*	*	*
Taxes Accrued—Table 40 A :	*	*	*						*	*	*
Operating Income	*	*	*		*	*	*		*	*	*
Operating Loss.	*	*	*		*	*	*		*	*	*

The entries in the Income Account should be taken from the pages of the report, if mentioned; otherwise from the books of the company. The Income Account statement is to be presented on the basis of *accruals*, and every item should be given as *accrued* when that is possible.

Operating Revenues: This account includes the total operating revenues as returned on table 22.

Operating Expenses: This account includes the total operating expenses as returned on table 32.

Outside Operations—Revenues: This account includes the revenues from outside operations as returned on table 33.

Outside Operations—Expenses: This account includes the expenses of outside operations as returned on table 33.

Taxes Accrued: This account includes State, county, municipal, school, and other taxing-district taxes assessed on property of all kinds owned by the respondent, or on leased property the taxes or assessments on which are assumed and treated by the respondent as part of its taxes, and so returned in table "A" on table 40. This account should not include taxes on "Other properties" and such taxes or assessments as are properly chargeable to Operating Expenses, Betterments, or Construction.

The charges for the fiscal year may be based on estimates; discrepancies, if any, between the estimates and the actual assessments in the respective States to be adjusted when known. As it is intended that one-twelfth of the estimated annual taxes should be charged monthly to this account, an open account should be kept, to which should be credited from month to month the charges so made, and to which should be charged the actual taxes when paid.

Table 19. (*Continued.*)

INCOME ACCOUNT. (*Continued.*)

Other Income :												
Rents Accrued from Lease of Road—Table 35	*	*	*						*	*	*	
Other Rents—Credits :												
a) Hire of Equipment—Balance—Table 39					*	*	*		*	*	*	
b) Joint Facilities—Table 34					*	*	*		*	*	*	
c) Miscellaneous Rents - Table 35					*	*	*		*	*	*	
	*	*	*						*	*	*	
Separately Operated Properties—Profit—Table 37 . .	*	*	*						*	*	*	
Dividends Declared on Stocks Owned or Controlled—Tables 24 and 28.	*	*	*						*	*	*	
Interest Accrued on Funded Debt Owned or Controlled - Tables 26 and 28	*	*	*						*	*	*	
Interest on Other Securities, Loans, and Accounts, Miscellaneous Income—Table 35	*	*	*						*	*	*	
Total Other income. . . .	*	*	*		*	*	*					
Gross Corporate Income carried forward. . .	*	*	*		*	*	*					
Gross Corporate Loss carried forward	*	*	*		*	*	*					

Rents Accrued from Lease of Road : This account includes amounts accrued as rents receivable for the use o property owned or controlled by the reporting company and leased to another company as returned on table 35.

Hire of Equipment—Balance : This account includes the credit balance from hire of equipment as returned on table 39.

Joint Facilities : This account includes the purely rental portion, including proportion of taxes, accruing to the respondent from the joint use of tracks, yards, and other facilities owned by it but used jointly with other carriers as returned on table 34.

This account should not be confused with the "Joint-facilities" accounts prescribed in the Classification of Operating Expenses.

Miscellaneous Rents : This account includes all rents not specifically provided for in the three previous rental accounts. It should not be confused with Account No. 18, "Rents of buildings and other property" of Operating Revenues, on table 22.

Separately Operated Properties—Profit : This account includes amounts receivable under the terms of agreements or contracts, whereby the surplus resulting from the separate operation of the property of other companies having an independent corporate existence is receivable in whole or in part. (See table 37.)

Dividends Declared on Stocks Owned or Controlled : This account includes dividends declared during the fiscal year on stocks of other companies owned or controlled by the respondent as returned on tables 24 and 28.

Interest Accrued on Funded Debt Owned or Controlled : This account includes interest accrued on bonds of other companies owned by respondent and eld in its treasury, bonds deposited as collateral, bonds deposited in trust, or bonds controlled through lease or otherwise, the income from which accrues to it; also interest accrued on all other classes of funded debt. This entry should be the total of income from railway and miscellaneous funded debt owned as returned on tables 26 and 28. Interest accrued should not be credited unless the income is reasonably assured by past experience, guarantee, anticipated provision, or otherwise. In other cases, the credit to this account should be based upon the interest actually collected, crediting within the year the portion earned.

Interest on Other Sicurities, Loans, and Accounts : This account includes interest receivable on all securities not provided for in the foregoing account; also interest receivable on notes, loans, bank balances, and other accounts.

Miscellaneous Income : This account includes all other items of income not specifically provided for elsewhere. (See table 35.)

As the remarks governing the treatment of items under "Deductions from Gross Corporate Income" table 20 are the reverse of the foregoing, the same are not repeated here.

Table 20.

INCOME ACCOUNT (*Concluded*).

Gross Corporate Income brought forward	*	*	*		*	*	*					
Gross Corporate Loss brought forward	*	*	*		*	*	*					
Deductions from Gross Corporate Income :												
Rents Accrued for Lease of Other Roads—Table 37	*	*	*						*	*	*	
Other Rents—Debits :												
a) Hire of Equipment—Balance—Table 39					*	*	*		*	*	*	
b) Joint Facilities—Table 36					*	*	*		*	*	*	
c) Miscellaneous Rents—Table 37					*	*	*		*	*	*	
	*	*	*						*	*	*	
Separately Operated Properties—Loss—Table 37	*	*	*						*	*	*	
Interest Accrued on Funded Debt—Table 13	*	*	*						*	*	*	
Other Interest	*	*	*						*	*	*	
Sinking Funds Chargeable to Income	*	*	*						*	*	*	
Other Deductions—Table 37	*	*	*						*	*	*	
Total Deductions from Gross Corporate Income :	*	*	*		*	*	*					
Net Corporate Income	*	*	*		*	*	*					
Net Corporate Loss	*	*	*		*	*	*					
Disposition of Net Corporate Income :												
Dividends Declared :												
a) On Preferred Stock—Table 10 :												
per cent payable					*	*	*		*	*	*	
per cent payable					*	*	*		*	*	*	
per cent payable					*	*	*		*	*	*	
per cent payable					*	*	*		*	*	*	
Total	*	*	*						*	*	*	
b) On Common Stock—Table 10 :												
per cent payable					*	*	*		*	*	*	
per cent payable					*	*	*		*	*	*	
per cent payable					*	*	*		*	*	*	
per cent payable					*	*	*		*	*	*	
Total	*	*	*						*	*	*	
c) On Other Securities—Table 10 :												
per cent payable	*	*	*						*	*	*	
Additions and Betterments Charged to Income. (Table 16)	*	*	*						*	*	*	
Appropriations to Reserves	*	*	*						*	*	*	
Miscellaneous :												
					*	*	*		*	*	*	
					*	*	*		*	*	*	
					*	*	*		*	*	*	
					*	*	*		*	*	*	
	*	*	*						*	*	*	
	*	*	*		*	*	*					
Balance for Year Carried Forward to Profit and Loss.	*	*	*		*	*	*					

Disposition of Net Corporate Income :

Dividends Declared: This account includes all dividends declared out of income earned during the period for which the Income Account is made Whether dividends shall be declared payable out of income for the year or out of the surplus shown in the Profit and Loss account, or both, is left to the discretion of the respondent. The sum of dividends on stock shown on the opposite page and the dividends on stock declared out of surplus shown on table 21 should equal the amount shown as "Dividends declared during year" on table 10.

Additions and Betterments Charged to Income: This account includes all expenditures for additions and betterments made during the current year which are chargeable to income as returned on table 16.

Appropriations to Reserves: This account includes appropriations from corporate income for insurance funds, relief funds, funds for additions and betterments, new lines and extensions, extraordinary emergencies, etc. Expenditures for operating expenses should not be charged against these reserves.

Miscellaneous: This account should show in detail all appropriations from income not otherwise specifically provided for.

Table 21.

—

PROFIT AND LOSS ACCOUNT.

DEBIT.		CREDIT.	
Balance June 30, 1908		Balance June 30, 1908	
Balance for year brought forward from Income Account.		Balance for year brought forward from Income Account.	
Other Properties : Loss—Table 33 *B*		Other Properties : Profit—Table 33 *B*	
Deductions for Year :		Additions for Year :	
Dividends Declared out of Surplus :			
a) On Preferred Stock—Table 10.			
per cent payable			
per cent payable			
b) On Common Stock—Table 10.			
per cent payable			
per cent payable			
c) On Other Securities—Table 10.			
per cent payable			
Balance Credit, June 30, 1909, carried to Balance Sheet—Table 42		Balance Debit, June 30, 1909, carried to Balance Sheet—Table 41	

Table 22.

OPERATING REVENUES.

ACCOUNT,	Total Receipts.	Total Deductions	Total Revenues.
I. Revenue from Transportation :			
The proportion of receipts for joint traffic belonging to other carriers should not be included.			
1. Freight Revenue			
2. Passenger Revenue.			
3. Excess Baggage Revenue			
4. Parlor and Chair Car Revenue.			
5. Mail Revenue			
6. Express Revenue			
7. Milk Revenue (on Passenger Trains)			
8. Other Passenger-Train Revenue			
Total Passenger Service Train Revenue (Accounts Nos. 2 to 8).			
9. Switching Revenue.			
10. Special Service Train Revenue.			
11. Miscellaneous Transportation Revenue			
Total Revenue from Transportation (Accounts Nos 1 to 11)			
II. Revenue from Operations other than Transportation.			
12. Station and Train Privileges.			
13. Parcel-Room Receipts.			
14. Storage—Freight.			
15. Storage—Baggage			
16. Car Service			
17. Telegraph and Telephone Service			
18. Rents of Buildings and Other Property			
19. Miscellaneous			
Total Revenue from Operation Other than Transportation			
20. Joint Facilities Revenue—Dr.			
21. Joint Facilities Revenue—Cr.			
Total Operating Revenues			

Table 23.

OPERATING REVENUES. (*Concluded.*)

DEDUCTIONS FROM TOTAL RECEIPTS.

NAME OF REVENUE ACCOUNT.	Classification of Repayments.							Total Deductions.
	Overcharges and Overcollections.	Switching Charges Absorbed.	Allowances and Arbitraries.	Transfers.	Uncollected Earnings.	Fares Refunded and Tickets Redeemed.	Other Repayments.	
1. Freight Revenue								
2. Passenger Revenue								
3. Excess Baggage Revenue								
4. Parlour and Chair Car Revenue								
5. Mail Revenue								
6. Express Revenue								
7. Milk Revenue (on Passenger Trains)								
8. Other Passenger-Train Revenue								
9. Switching Revenue								
10. Special Service Train Revenue								
11. Miscellaneous Transportation Revenue								
12. Station and Train Privileges								
13. Parcel-Room Receipts								
14. Storage — Freight								
15. Storage — Baggage								
16. Car Service								
17. Telegraph and Telephone Service								
18. Rents of Buildings and other Property								
19. Miscellaneous								
20. Joint Facilities Revenue — Dr.								
21. Joint Facilities Revenue — Cr.								

Table 24.

RAILWAY STOCKS OWNED.

I. — ACTIVE CORPORATIONS.

NAME OF CORPORATION AND SECURITY.	Par Value of Stocks Owned not Held in Sinking or Other Funds.		Dividends Declared.		Valuation of Stocks Owned.
	Unpledged.	Pledged.	Rate.	Amount.	
Stocks of Respondent Corporation :					
Stocks of Corporations whose Property forms a Part of the Operating System of Respondent Corporation :					
Stocks of Corporations whose Property does not form a Part of the Operating System of Respondent Corporation :					

Table 25.

RAILWAY STOCKS OWNED (*Concluded*).

II. — INACTIVE CORPORATIONS.

NAME OF CORPORATION.	Name of Security.	Total par Value of Stock Outstanding.	Par Value of Stocks Owned.		Valuation of of Stocks Owned.
			Unpledged.	Pledged.	

Table 26

—

RAILWAY FUNDED DEBT OWNED.

I. — ACTIVE CORPORATIONS.

NAME OF CORPORATION AND SECURITY.	Par Value of Funded Debt owned not Held in Sinking or other Funds.		Interest Accrued.		Valuation of Funded Debt Onwed.
	Unpledged.	Pledged.	Rate.	Amount.	
Funded Debt of Respondent Corporation					
Funded Debt of Corporations whose Property forms a Part of the Operating System of Respondent Corporation :					
Funded Debt of Corporations whose Property does not form a Part of the Operating System of Respondent Corporation :					

Table 27

—

RAILWAY FUNDED DEBT ONWED. (*Concluded.*)

II. — INACTIVE CORPORATIONS

NAME OF CORPORATION.	Name of Scurity.	Total par Value of Funded Debt Outstanding.	Par Value of Funded Debt Owned.		Valuation of Funded Debt Owned.
			Unplegded.	Plegded.	

Does respondent own or control any railway securites, either stock or funded debt, through any intermediary which does not make an annual report to the Interstate Commerce Commission?

Insert below a list of such holdings, if any, giving name of corporation and security held, par value of holdings, and name of intermediary through which control of such securities is established.

NAME OF CORPORATION.	Name of security Held.	Par Value of securies Held.	Name of Intermediary.

Table 28.

MISCELLANEOUS STOCKS AND FUNDED DEBT OWNED.

A. — OTHER THAN RAILWAY STOCKS.

NAME.	Total par value of Securities Owned.	Dividends Declared.		Valuation of Securities Owned.
		Rate.	Amount.	

B. — OTHER THAN RAILWAY FUNDED DEBT.

NAME.	Total par value of Securities Owned.	Interest Accrued.		Valuation of Securities Owned.
		Rate.	Amount.	

Table 29.

SINKING, REDEMPTION, INSURANCE, AND OTHER SPECIAL FUNDS.

A. — INCOME AND DISBURSEMENTS DURING YEAR.

NAME OF FUND.	Income.				Disbursements.
	Cash appropriations to Fund.	Income to fund from investments.	Other income to Fund.	Total.	
Sinking and Redemption Funds . . .					
Total . .					
Insurance and Other Special Funds. .					
Total . .					

B. — ASSETS ON JUNE 30, 1909.

NAME OF FUND AND SECURITY.	Securities in Fund.		Cash in Fund.	Total.
	Par Value.	Cost.		
Sinking and Redemption Funds				
Insurance and Other Special Funds				

Table 30.

OPERATING EXPENSES.

The entries in the column headed « Ratio A » should show the proportion of the several accounts to their respective subtotals indicated by italic type. The entries in the column headed « Ratio B » should show the proportion of the several accounts and subtotals to « Total operating expenses, excluding joint-facility accounts », etc., on table 32.

ACCOUNT	Amount.	Ratio A. (Per cent).	Ratio B. (Per cent).
I. Maintenance of way and structures :			
1. Superintendence			
2. Ballast			
3. Ties			
4. Rails			
5. Other Track Material			
6. Roadway and Track			
7. Removal of Snow, Sand, and Ice			
8. Tunnels			
9. Bridges, Trestles, and Culverts			
10. Over and Under Grade Crossings			
11. Grade Crossings, Fences, Cattle Guards, and Signs			
12. Snow and Sand Fences and Snowsheds			
13. Signals and Interlocking Plants			
14. Telegraph and Telephone Lines			
15. Electric Power Transmission			
16. Buildings, Fixtures, and Grounds			
17. Docks and Wharves			
18. Roadway Tools and Supplies			
19. Injuries to Persons			
20. Stationery and Printing			
21. Other Expenses			
Total of Accounts Nos. 1 to 21			
II. Maintenance of Equipment :			
24. Superintendence			
25. Steam Locomotives—Repairs			
26. Steam Locomotives—Renewals			
27. Steam Locomotives—Depreciation			
28. Electric Locomotives—Repairs			
29. Electric Locomotives—Renewals			
30. Electric Locomotives—Depreciation			
31. Passenger-train Cars—Repairs			
32. Passenger-train Cars—Renewals			
33. Passenger-train Cars—Depreciation			
34. Freight-train Cars—Repairs			
35. Freight-train Cars—Renewals			
36. Freight-train Cars—Depreciation			
37. Electric Equipment of Cars—Repairs			
38. Electric Equipment of Cars—Renewals			
39. Electric Equipment of Cars—Depreciation			
40. Floating Equipment—Repairs			
41. Floating Equipment—Renewals			
42 Floating Equipment—Depreciation			
43. Work Equipment—Repairs			
44. Works Equipment—Renewals			
45. Work Equipment—Depreciation			
46. Shop Machinery and Tools			
47. Power Plant Equipment			
48. Injuries to Persons			
49. Stationery and Printing			
50. Other Expenses			
Total of Accounts Nos. 24 to 50			

Table 31.

OPERATING EXPENSES (*Continued*).

ACCOUNT.	Amount.	Ratio A. (Per cent.)	Ratio B. (Per cent.)
III. Traffic Expenses:			
53. Superintendence			
54. Outside Agencies			
55. Advertising			
56. Traffic Associations			
57. Fast Freight Lines			
58. Industrial and Immigration Bureaus			
59. Stationery and Printing			
60. Other Expenses			
Total of Accounts Nos. 53 to 60.			
IV. Transformation Expenses:			
61. Superintendence			
62. Dispatching Trains			
63. Station Employees			
64. Weighing and Car-Service Associations			
65. Coal and Ore Docks			
66. Station Supplies and Expenses			
67. Yardmasters and their Clerks			
68. Yard Conductors and Brakemen			
69. Yard Switch and Signal Tenders			
70 Yard Supplies and Expenses			
71. Yard Enginemen			
72. Engine-house Expenses—Yard			
73. Fuel for Yard Locomotives			
74. Water for Yard Locomotives			
75. Lubricants for Yard Locomotives			
76. Other Supplies for Yard Locomotives			
79. Motormen			
80. Road Enginemen			
81. Engine-house Expenses—Road			
82. Fuel for Road Locomotives			
83. Water for Road Locomotives			
84. Lubricants for Road Locomotives			
85. Other Supplies for Road Locomotives			
86. Operating Power Plants			
87. Purchased Power			
88. Road Trainmen			
89. Train Supplies and Expenses			
90. Interlockers and Block and Other Signals—Operation			
91. Crossing Flagmen and Gatemen			
92. Drawbridge Operation			
93. Clearing Wrecks			
94. Telegraph and Telephone—Operation			
95. Operating Floating Equipment			
96. Express Service			
97. Stationery and Printing			
98. Other Expenses			
99. Loss and Damage—Freight			
100. Loss and Damage—Baggage			
101. Damage to Property			
102. Damage to Stock on Right of Way			
103. Injuries to Persons			
Total of Accounts Nos 61 to 103 (excepting Nos. 77 and 78).			

*

Table 32.

—

OPERATING EXPENSES (*Concluded*).

ACCOUNT.	Amount.	Ratio A. (Per cent.)	Ratio B. (Per cent.)
V. General Expenses :			
106. Salaries and Expenses of General Officers			
107. Salaries and Expenses of Clerks and Attendants			
108. General Office Supplies and Expenses			
109. Law Expenses			
110. Insurance			
111. Relief Department Expenses			
112. Pensions			
113. Stationery and Printing			
114. Other Expenses			
Total of Accounts Nos. 106 to 114.			
Total operating expenses. (Excluding "Joint-Facility" Accounts Nos. 22, 23, 51, 52, 77, 78, 104, 105, 115 and 116.)			

SUMMARY.

ACCOUNT.	Item.	Amount.
Maintenance of Way and Structures :		
Total of Accounts Nos. 1 to 21		
22. Maintaining Joint Tracks, Yards, and Other Facilities - Dr.		
23. Maintaining Joint Tracks, Yards, and Other Facilities—Cr.		
Total—Maintenance of Way and Structures.		
Ratio to Total Operating Expenses (per cent) *		
Maintenance of Equipment :		
Total of Accounts Nos. 24 to 50.		
51. Maintaining Joint Equipment at Terminals—Dr		
52. Maintaining Joint Equipment at Terminals—Cr.		
Total—Maintenance of Equipment.		
Ratio to Total Operating Expenses (per cent) *		
Traffic Expenses :		
Total of Accounts Nos. 53 to 60		
Total—Traffic Expenses.		
Ratio to Total Operating Expenses (per cent) *		
Transportation Expenses :		
Total of Accounts Nos. 61 to 103 (excepting Nos. 77 and 78)		
77. Operating Joint Yards and Terminals—Dr.		
78. Operating Joint Yards and Terminals—Cr.		
104. Operating Joint Tracks and Facilities—Dr.		
105. Operating Joint Tracks and Facilities—Cr.		
Total—Transportation Expenses		
Ratio to Total Operating Expenses (per cent) *		
General Expenses :		
Total of Accounts Nos. 106 to 114.		
115. General Administration Joint Tracks, Yards, and Terminals—Dr.		
116. General Administration Joint Tracks, Yards, and Terminals—Cr.		
Total—General Expenses.		
Ratio to Total Operating Expenses (per cent) *		
Total Operating Expenses.		
Ratio of Operating Expenses to Operating Revenues (per cent) *.		

Table 33.

SUMMARY OF REVENUES AND EXPENSES OF OUTSIDE OPERATIONS AND OTHER PROPERTIES.

A. — OUTSIDE OPERATIONS.

This table should show the revenues, expenses, and net revenue or deficit of each of the "Outside operations" of the respondent listed on table 8. A detailed statement of these accounts is required in Annual Report Form D—Outside Operations.

DESIGNATION.	Revenues.	Expenses.	Net Revenue or Deficit.
1. Boat Lines			
2. Ferry Lines			
3. Harbour Terminal Transfers			
4. Electric Railways			
5. Express Lines			
6. Cab and Omnibus Service			
7. Sleeping-Car Service			
8. Parlour and Chair Car Service			
9. Dining and Special Car Service			
10. Electric Light and Power Plants			
11. Gas-Producing Plants			
12. Canals			
13. Grain Elevators			
14. Stock Yards			
15. Commercial Telegraph and Telephone Lines			
16. Hotels and Restaurants			
17. Amusement Parks and Resorts			
18. Coal Storage Plants			
19. Gold-Storage Plants			
20. Commercial Ice-Supply Plants			
21. Public Toll-Bridge Service			
Miscellaneous :			

B. — OTHER PROPERTIES.

This table provides for a statement of the revenues, expenses, taxes, and income or loss of the "Other properties" named on table 8.

DESIGNATION.	Revenues.	Expenses.	Taxes.	Income or Loss

Table 34.

RENTS RECEIVABLE.

1° FROM JOINT FACILITIES.

This account is intended for the *rental* portion only of the joint-facility accounts and should not include the cost of maintenance, operation, or administration of joint facilities as provided for by the Classification of Operating Expenses.

Joint Tracks:—Under this heading should be included all rents accrued receivable for the joint use of tracks, including proportion of taxes accrued on property so used payable by other companies.

Joint Yards and Terminals:—Under this heading should be included all rents accrued receivable for the joint use of yards, terminals, and other facilities, including proportion of taxes accrued on property so used payable by other companies.

The total rents accrued receivable for the use of joint facilities should be carried to the Income Account on table 19 and entered as "Joint facilities," under "Other rents—Credits."

Facility Leased.	Location.	Name of Lessee.	Amount.
Joint Tracks:			
Joint Yards and Terminals:			

Table 35.

RENTS RECEIVABLE (*Concluded*).

2° FROM LEASE OF ROAD.

Road Leased.	Location.	Name of Lessee.	Amount.

This account includes amounts accrued as rents receivable for road owned or controlled by the respondent and leased to another company, the terms of the lease or contract granting exclusive use and control for operating purposes

3° MISCELLANEOUS RENTS.

Description of Property.	Location.	Name of Lessee.	Amount.

Under "Miscellaneous rents" should be given all rents accrued receivable for use of properties not otherwise specified under "Rents receivable," and the total should be carried to the Income Account on table 19 and entered as "Miscellaneous rents" under "Other rents—Credits." Only the more important items need to be specified. Minor items may be aggregated. This account should not be confused with Account No. 18, "Rents of buildings and other property," of Operating Revenues on table 22.

MISCELLANEOUS INCOME.

SOURCE OF INCOME.	Gross Income.	Expenses.	Net Miscellaneous Income.

Under this heading should be shown all rents of buildings and other property not used *directly in connection with* the operations of the respondent, and all other items of income not specifically provided for elsewhere. The designation of all items included in "Miscellaneous income" should clearly indicate their character or else they should be explained under "Explanatory Remarks" below.

Expenses for the maintenance of the property from which miscellaneous income is derived, and the expenses incurred in securing that income, should be stated under the heading of "Expenses" and the difference entered in the column headed "Net miscellaneous income."

Table 36.

RENTS PAYABLE.

As the instructions governing these accounts are the reverse of those governing » Rents Receivable » the same are not repeated.

1° FOR JOINTS FACILITIES.

FACILITY LEASED.	Location.	Name of Lessor.	Amount.
Joint Tracks:			
Joint Yards and Terminals:			

Table 37.

RENTS PAYABLE. (*Concluded*).

2° FOR LEASE OF ROAD.

ROAD LEASED.	Guaranteed Interest on Bonds.	Guaranteed Dividends on Stock.	Cash.	Total.

3° MISCELLANEOUS RENTS.

Description of Property.	Location.	Name of Lessor.	Amount.

OTHER DEDUCTIONS FROM INCOME.

NATURE OF DEDUCTION.	Amount.

SEPARATELY OPERATED PROPERTIES.

Name of Property.	Location.	Profit	Loss.

Table 38.

HIRE OF EQUIPMENT.

This statement covers only direct leases and not interchange of equipment.

A. — EQUIPMENT LEASED.

KIND OF EQUIPMENT.	Name of lessee.	Number of Units.	Amount.
Rents Accrued Receivable			

KIND OF EQUIPMENT.	Name of lessor.	Number of Units.	Amount
Rents Accrued Payable			

B. — EQUIPMENT INTERCHANGED.

KIND OF EQUIPMENT.	Basis of payment.				Compensation.	
	Number Locomotive-Days.	Number Locomotive miles.	Number Car-Days.	Number Car-Miles.	Rate.	Amount.
I. Accrued on Equipment Borrrowed :						
Passenger Locomotives						
Freight Locomotives						
Work Locomotives.						
Passenger-Train Cars						
Freight-Train Cars.						
Works Cars						
Total . .						
II. Accrued on Equipment Loaned :						
Passenger Looomotives						
Freight Locomotives						
Work Locomotives						
Passenger-Train Cars.						
Freight-Train Cars.						
Work Cars						
Total . .						

Table 39

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HIRE OF EQUIPMENT. (*Concluded*).

C. — PRIVATE CARS.

Cars Used.		Number Car-Miles.	Compensation.	
Name of Owner.	Description.		Rate.	Amount.

RECAPITULATION OF HIRE OF EQUIPMENT.

ACCOUNT.	Amount Receivable.	Amount Payable.
A. — Equipment Leased		
B. — Equipment Interchanged		
C. — Private Cars		
Total		
Balance (As shown in Income Account.)		

Table 40.

TAXES AND ASSESSMENTS.

A. — FOR REPORTING COMPANY'S OWNED AND PROPRIETARY LINES.

STATE OF TERRITORY.	Ad valorem Tax.		Specifix Tax.			On Property Owned, not Used in Operation, and Miscellaneous.	Internal Revenue, U. S. Government.	Total.
	On the Value of Real and Personal Property.	On the Value of Stocks or Bonds : or on Valuation Based on Earnings, Dividends, or other Results of Operation.	On Stocks Bonds, Loans, etc.	On Gross or Net Earnings, Revenue, or Dividends.	On Traffic, or some Physical Quality of Property Operated, or on Privilege.			

B. — FOR REPORTING COMPANY'S LEASED AND OPERATED LINES.

NAME OF ROAD.	Ad valorem Tax.		Specifix Tax.			On property Owned, not Used in Operation, and Miscellaneous.	Internal Revenue, U. S. Government.	Total.
	On the Value of Real and Personal Property.	On the Value of Stocks or Bonds : or on Valuation Based on Earnings, Dividends, or other Results of Operation.	On Stocks Bonds, Loans, etc.	On Gross or Net Earnings, Revenue, or Dividends.	On traffic, or some Physical Quality of Property Operated, or on Privilege.			

Table 41.

COMPARATIVE GENERAL BALANCE SHEET.

See also Table 60-61.

June 30, 1908		Assets.	June 30, 1909.		Year Ending June 30, 1909.	
Item.	Total.		Item.	Total.	Increase,	Decrease.
		Cost of Road—Table 17				
		Cost of Equipment—Table 18 . . .				
		General Expenditures—Table 18 . .				
		Stocks Owned—Tables 24, 25 and 28				
		Funded Debt Owned—Tables 26, 27, and 28				
		Other Permanent Investments. . .				
		Lands Owned				
		Cashand Current Assets—Table 14 .				
		Other Assets:				
		Equipment Trusts				
		Materials and Supplies—Table 14				
		Sinking, Insurance, and Other Funds—Table 29				
		Sundries.				
		Profit and Loss—Table 21				
		Grand Total. . .				

Table 42.

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COMPARATIVE GENERAL BALANCE SHEET (*Concluded*).

June 30, 1908.		Liabilities.	June 30, 1909.		Year Ending June 30, 1909.	
Item.	Total.		Item.	Total.	Increase.	Decrease.
		Capital Stock—Table 10				
		Funded Debt—Table 13. . . .				
		Current Liabilities—Table 14 . . .				
		Accrued Interest on Funded Debt not yet payable				
		Profit and Loss (Table 21)				
		Grand Total. . .				

Table 43.

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IMPORTANT CHANGES DURING THE YEAR.

Here present statements as follows : 1° All Extensions of Road put in Operation. 2° Decrease in Mileage by Line Abandoned or Line Straightened. 3° All other important Physical Changes. 4° All Leases taken or surrendered. 5° All Consolidations or Reorganizations effected. 6° All new Stocks issued. 7° All new Funded Debt issued. 8° All changes in the respondent's holdings of Stocks and Funded Debt. 9° All other important Financial Changes.

Table 44.

CONTRACTS, AGREEMENTS, ETC.

Here give a concise statement of all Contracts, Agreements, Arrangements, etc., with other Companies or persons, concerning the Transportation of Freight or Passengers, which became effective during the year covered by this report. Give the statement in the following order, *viz* : 1° Express Companies. 2° Mails. 3° Sleeping, Parlour, or Dining Car Companies. 4° Freight or Transportation Companies or Lines. 5° Other Railroad Companies. 6° Steamboat or Steamship Companies. 7° Telegraph Companies. 8° Telephone Companies. 9° Other Contracts.

Table 45.

EMPLOYEES AND SALARIES.

CLASS.	Number on June 30.	Total Number of Days Worked.	Total Yearly Compensation.	Average Daily Compensation.
General Officers				
Other Officers				
General Office Clerks				
Station Agents				
Other Station Men				
Enginemen				
Firemen				
Conductors				
Other Trainmen				
Machinists				
Carpenters				
Other Shopmen				
Section Foremen				
Other Trackmen				
Switch Tenders, Crossing Tenders, and Watchmen				
Telegraph Operators and Dispatchers				
Employees—Account Floating Equipment				
All other Employees and Labourers				
TOTAL (Including "General Officers")				
Less "General Officers"				
TOTAL (Excluding "General Officers")				
Distribution of above :				
Maintenance of Way and Structures				
Maintenance of Equipment				
Traffic Expenses				
Transportation Expenses				
General Expenses				
Outside Operations				
TOTAL (Including "General Officers")				
Less "General Officers"				
TOTAL (Excluding "General Officers")				

Table 46.

TRAFFIC AND MILEAGE STATISTICS.

ITEM.	Column for Number Passengers, Tonnage, etc.	Columns for Revenue and Rates.		
		Dollars.	Cts.	Mills.
Passenger Traffic :				
1. Number of Passengers Carried Earning Revenue				
2. Number of Passengers Carried One Mile				
3. Number of Passengers Carried One Mile per Mile of Road				
4. Average Distance Carried * miles.				
5. Total Passenger Revenue—Table 22.				
6. Average Amount Received from each Passenger †.				
7. Average Receipts per Passenger per Mile †				
8. Total Passenger Service Train Revenue—Table 22.				
9. Passenger Service Train Revenue per Mile of Road *.				
10. Passenger Service Train Revenue per Train-Mile †				
Freight Trafic :				
11. Number of Tons Carried of Freight Earning Revenue—Table 48				
12. Number of Tons Carried One Mile				
13. Number of Tons Carried One Mile per Mile of Road				
14. Average Distance Haul of One Ton * miles				
15. Total Freight Revenue—Table 22				
16. Average Amount Received for each Ton of Freight †.				
17. Average Receipts per Ton per Mile †				
18. Freight Revenue per Mile of Road *				
19. Freight Revenue per Train-Mile †				
Total Traffic :				
20. Operating Revenues—Table 22				
21. Operating Revenues per Mile of Road *.				
22. Operating Revenues per Train-Mile †.				
23. Operating Expenses—Table 32				
24. Operating Expenses per Mile of Road *.				
25. Operating Expenses per Train-Mile †.				
26. Net Operating Revenue (or Deficit)—Table 19				
27. Net Operating Revenue (or Deficit) per Mile of Road *				
28. Average Number of Passengers per Car-Mile.				
29. Average Number of Passengers per Train-Mile				
30. Average Number of Passenger Cars per Train-Mile *				
31. Average Number of Tons of Freight per Loaded Car-Mile *.				
32. Average Number of Tons of Freight per Train-Mile *				
33. Average Number of Freight Cars per Train-Mile *				
34. Averrge Number of Loaded Cars per Train-Mile *				

METHODS OF OBTAINING AVERAGES INDICATED BY NUMBERED ITEMS.

The items on tables 46 and 47 are numbered consecutively and reference to them is made in the instructions below without specific mention of pages.

* 4. *Average distance carried:*—Divide "2. Number of passengers carried one mile" by "1. Number of passengers carried earning revenue."

†6. *Average amount received from each passenger:*—Divide "5. Total passenger revenue" by "1. Number of passengers carried earning revenue."

†7. *Average receipts per passenger per mile:*—Divide "5. Total passenger revenu" by "2. Number of passengers carried one mile."

8. *Total passenger service train revenue:*—This entry should be the amount shown as a subtotal against this designation on table 22, this being the sum of accounts 2 to 8, inclusive, of "Operating revenues."

†10. *Passenger service train revenue per train-mile:*—Divide "8. Total passenger service train revenue" by the sum of "62. Pasenger train-miles" and "63. Mixed train-miles."

* 14. *Average distance haul of one ton:*—Divide "12. Number of tons carrieb one mile" by "11. Number of tons carried of freight earning revenue."

†16. *Average amount received for each ton of freight;*—Divide "15. Total freight revenue" by "11. Number of tons carried of freight earning revenue."

†17. *Average receipts per ton per mile:*—Divide "15. Total freight revenue" by "12. Number of tods carried one mile."

†19. *Freight revenue per train-mile:*—Divide "15. Total freight revenue" by the sum of "61. Freight train-miles" and "63. Mixed train-miles."

†22. *Operating revenues per train-mile:*—Divide "20. Operating revenues" by "65. Total revenue train mileage."

†25. *Operating expenses per train-mile:*—Divide "23. Operating expenses" by "65. Total revenue train mileage."

28. *Average number of passengers per car mile:*—Divide "2. Number of passengers carried one mile," by the sum of "48. Passenger" and "49. Sleeping, parlour, and observation."

29. *Average number of passengers per train-mile:*—Divide "2. Number of passengers carried one mile," by the sum of "62. Passenger train-miles," and "63. Mixed train-miles."

* 30. *Average number of passenger cars per train-mile:*—Divide "51. Total passenger car-miles," by the sum of "62. Passenger train-miles," and "63. Mixed train-miles."

* 31. *Average number of tons of freight per loaded car-mile:*—Divide "12. Number of tons carried one mile," by "44. Freight car-miles—Loaded."

* 32. *Average number of tons of freight per train-mile:*—Divide "12. Number of tons carried one mile," by the sum of "61. Freight train-miles," and "63. Mixed train-miles."

* 33. *Average number of freight cars per train-mile:*—Divide "47. Total freight car-miles," by the sum of "61. Freight train-miles," and "63. Mixed train-miles."

* 34. *Average number of loaded cars per train-mile:*—Divide "44. Freight car-miles—Loaded," by the sum of "61. Freight train-miles," and "63. Mixed train-miles."

* 35. *Average number of empty cars per train-mile:*—Divide "45. Freight car-miles—Empty," by the sum of "61. Freight train-miles," and "63. Mixed train-miles."

* 36. *Average mileage operated during year:*—This item should fairly represent the mean of the mileage operated during the year (*including* "Line operated under trackage rights"), which should be used in obtaining "Per mile of road" items. If but slight changes occurred, "Total mileage operated" (single track) as returned in Table "A" of table 55 may be used.

Table 47.

TRAFFIC AND MILEAGE STATISTICS. (*Concluded.*)

CLASSIFICATION.	Item.	Total.
Locomotive Mileage :		
Revenue Service.		
37. Freight Locomotive-Miles		
38. Passenger Locomotive-Miles		
39. Mixed Locomotive-Miles		
40. Special Locomotive-Miles		
41. Switching Locomotive Miles		
42. Total Revenue Locomotive Mileage.		
43. Non-revenue Service Locomotive-Miles.		
Car Mileage :		
Revenue Service.		
Freight Car-Miles.		
44. Loaded		
45. Empty		
46. Caboose		
47. Total Freight Car-Miles.		
Passenger Car-Miles.		
49. Sleeping, Parlour, and Observation		
50. Other Passenger-Train Cars		
51. Total Passenger Car-Miles.		
Special Car-Miles.		
52. Freight-loaded		
53. Freight-empty		
54. Caboose		
55. Passenger.		
56. Sleeping, Parlour, and Observation		
57. Other Passenger-Train-Cars		
58. Total Special Car-Miles.		
59. Total Revenue Car Mileage.		
60. Non-revenue Service Car-Miles		
Train Mileage :		
Revenue Service.		
61. Freight Train-Miles		
62. Passenger Train-Miles		
63. Mixed Train-Miles.		
64. Special Train-Miles		
65. Total Revenue Train Mileage.		
66. Non-revenue Service Train-Miles		

Table 48.

FREIGHT TRAFFIC MOVEMENT.

(COMPANY'S MATERIAL EXCLUSED.)

COMMODITY.		Freight Originating on this Road.	Freight received from Connecting roads and other Carriers.	Total Freight Tonnage.	
		Whole Tons.	Whole Tons.	Whole Tons.	Per Cent.
Products of Agriculture.	Grain				
	Flour				
	Other Mill Products				
	Hay				
	Tobacco				
	Cotton				
	Fruit and Vegetables				
	Other Products of Agriculture				
	Total.				
Products of Animals.	Live Stock				
	Dressed Meats				
	Other Packing-House Products				
	Poultry, Game, and Fish				
	Wool				
	Hides and Leather				
	Other Products of Animals				
	Total.				
Products of Mines.	Anthracite Coal				
	Bituminous Coal				
	Coke				
	Ores				
	Stone, Sand, and other like articles				
	Other Products of Mines				
	Total.				
Products of Forests.	Lumber				
	Other Products of Forests				
	Total.				
Manufactures.	Petroleum and other Oils				
	Sugar				
	Naval Stores				
	Iron, Pig and Bloom				
	Iron and Steel Rails				
	Other Castings and Machinery				
	Bar and Sheet Metal				
	Cement, Brick, and Lime				
	Agricultural Implements				
	Wagons, Carriages, Tools, etc.				
	Wines, Liquors, and Beers				
	Household Goods and Furniture				
	Other Manufactures				
	Total.				
Merchandise					
Miscellaneous : Other commodities not mentioned above					
	Total Tonnage.				

Table 49.

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SELECTED COMMODITIES.

COMMODITY.	Freight Carried in Carload Lots.	Ton-Mileage of Freight Carried in Carload Lots.	Revenue from Freight Carried in Carload Lots.	Revenue per ton per mile from Freight Carried in Carload Lots.	
	Whole Tons.	Ton-Miles.	Dollars.	Cents.	Mills.
Grain					
Hay					
Cotton					
Live Stock					
Dressed Meats					
Anthracite Coal					
Bituminous Coal					
Lumber					

Table 50.

DESCRIPTION OF EQUIPMENT.

A. — EQUIPMENT OWNED OR LEASED IN SERVICE OF THE RESPONDENT.

ITEM.	Number on June 30, 1908.	Number Added during Year.	Number Retired during Year.	Number on June 30, 1909.	Number Fitted With:	
					Train Brake.	Automatic Coupler.
Locomotives-Owned or Leased :						
Passenger						
Freight						
Switching						
Total Locomotives in Service.						
Less Locomotives Leased						
Total Locomotives Owned.						
Cars-Owned or Leased :						
In Passenger Service :						
First-class Cars						
Second-class Cars						
Combination Cars						
Emigrant Cars						
Dining Cars						
Parlour Cars						
Sleeping Cars						
Baggage, Express, and Postal Cars.						
Other Cars in Passenger Service						
Total.						
In Freight Service :						
Box Cars						
Flat Cars						
Stock Cars						
Coal Cars						
Tank Cars						
Refrigerator Cars						
Other Cars in Freight Service						
Total.						
In Company's Service :						
Officers' and Pay Cars.						
Gravel Cars						
Derrick Cars						
Caboose Cars.						
Other Road Cars						
Total.						
Total Cars in Service.						
Less Cars Leased						
Total Cars Owned.						
Cars Contributed to Fast Freight Line Service.						

B. — EQUIPMENT OWNED OR LEASED NOT IN SERVICE OF THE RESPONDENT.

Locomotives :						
Cars in Passenger Service						
Cars in Freight Service						
Cars in Company's Service						
Total Cars.						

Table 51.

DESCRIPTION OF EQUIPMENT. (*Continued.*)

SINGLE-EXPANSION LOCOMOTIVE.

CLASS.	Number.	Tractive Power. (Pounds)	Grate Surface (Sq. Ft.)	Heating Surface (Sq. Ft.)	Weight Exclusive of Tender. (Tons.)	Weight on Drivers. (Tons.)
Class A2,						
Class A3,						
Class A4,						
Class A5,						
Class A6,						
Class B2,						
Class B3,						
Class B4,						
Class B5,						
Class C1,						
Class C2,						
Class C3,						
Class C4.						
Class D2,						
Class D3,						
Class E2,						
Class E3,						
Claes E4,						
Class E5,						
Class E6,						
Class F2,						
Class F3,						
Class G2,						
Class G3,						
Class H2,						
Class H3,						
Class I2,						
Class I3,						
Class J2,						
Class K2,						
Class K3,						
Class						
Class						
Class						
Total. . .						
Average per Locomotive. . .						

Table 52.

DESCRIPTION OF EQUIPMENT. (*Continued.*)

FOUR-CYLINDER COMPOUND LOCOMOTIVES.

CLASS.	Number.	Tractive Power (Pounds.)	Grate Surface. (Sq. Ft.)	Heating Surface. (Sq. Ft.)	Weight Exclusive of Tender. (Tons.)	Weight on Drivers. (Tons.)
Class A2,						
Class A3,						
Class A4,						
Class A5,						
Class A6,						
Class B2,						
Class B3,						
Class B4,						
Class B5,						
Class C1,						
Class C2,						
Class C3,						
Class C4,						
Class D2,						
Class D3,						
Class E2,						
Class E3,						
Class E4,						
Class E5,						
Class E6,						
Class F2,						
Class F3,						
Class G2,						
Class G3,						
Class H2,						
Class H3,						
Class I2,						
Class I3,						
Class J2,						
Class K2,						
Class K3,						
Class						
Class						
Class						
Total. . .						
Average per Locomotive. . .						

Table 53.

DESCRIPTION OF EQUIPMENT. (*Continued.*)

TWO-CYLINDER COMPOUND OR CROSS COMPOUND LOCOMOTIVES.

CLASS.	Number.	Tractive Power. (Pounds.)	Grate Surface. (Sq. Ft.)	Heating Surface. (Sq. Ft.)	Weight Exclusive of Tender. (Tons.)	Weight on Drivers. (Tons.)
Class A2,						
Class A3,						
Class A4,						
Class A5,						
Class A6,						
Class B2,						
Class B3,						
Class B4,						
Class B5,						
Class C1,						
Class C2,						
Class C3,						
Class C4,						
Class D2,						
Class D3,						
Class E2,						
Class E3,						
Class E4,						
Class E5,						
Class E6,						
Class F2,						
Class F3,						
Class G2,						
Class G3,						
Class H2,						
Class H3,						
Class I2,						
Class I3,						
Class J2,						
Class K2,						
Class K3,						
Class						
Class						
Class						
Total. . .						
Average per Locomotive. . .						

Table 54.

DESCRITPION OF EQUIPMENT—Concluded.

CARS IN FREIGHT SERVICE CLASSIFIED ON THE BASIS OF CAPACITY.

ITEM.		Class I. Capacities in the 10,000's of Pounds.	Class II. Capacities in the 20,000's of Pounds.	Class III. Capacities in the 30,000's of Pounds.	Class IV. Capacities in the 40,000's of Pounds.	Class V. Capacities in the 50,000's of Pounds.	Class VI. Capacities in the 60,000's of Pounds.	Class VII. Capacities in the 70,000's of Pounds.	Class VIII. Capacities in the 80,000's of Pounds.
Box Cars	Number								
	Aggregate capacity, tons.								
Flat Cars	Number								
	Aggregate capacity, tons.								
Stock Cars	Number								
	Aggregate capacity, tons.								
Coal Cars	Number								
	Aggregate capacity, tons.								
Tank Cars	Number								
	Aggregate capacity, tons.								
Refrigerator Cars	Number								
	Aggregate capacity, tons.								
Other Cars	Number								
	Aggregate capacity, tons.								
Total	Number								
	Aggregate capacity, tons.								

ITEM.		Class IX. Capacities in the 90,000's of Pounds.	Class X. Capacities in the 100,000's of Pounds.	Class XI. Capacities in the 110,000's of Pounds.	Class XII. Capacities in the 120,000's of Pounds.	Class ... Capacities in the ...000's of Pounds.	Class ... Capacities in the ...000's of Pounds.	Class ... Capacities in the ...000's of Pounds.	Total all Classes.
Box Cars	Number								
	Aggregate capacity, tons.								
Flat Cars	Number								
	Aggregate capacity, tons.								
Stock Cars	Number								
	Aggregate capacity, tons.								
Coal Cars	Number								
	Aggregate capacity, tons.								
Tank Cars	Numher								
	Aggregate capacity, tons.								
Refrigerator Cars	Number								
	Aggregate capacity, tons.								
Other Cars	Number								
	Aggregate capacity, tons.								
Total	Number								
	Aggregate capacity, tons								

Table 55.

MILEAGE.

A. — Mileage of Road Operated (All Tracks).

LINE IN USE.	Line Owned.		Line of Proprietary Companies.	Line Operated under Lease.	Line Operated under Contract, Etc.	Line Operated under Trackage Rights.	Total Mileage Operated.	New Line Constructed During Year.	Rails.	
	Main Line.	Branches and Spurs.							Iron.	Steel.
Miles of single track										
Miles of second track										
Miles of third track										
Miles of fourth track										
Miles of yard track and sidings										
Total Mileage Operated (all tracks).										

B. — Mileage of Line Operated—by States and Territories (Single Track).

STATE OR TERRITORY.	Line Owned.		Line of Proprietary Companies.	Line Operated under Lease.	Line Operated under Contract, Etc.	Line Operated under Trackage Rights.	Total Mileage Operated.	New Line Constructed During Year.	Rails.	
	Main Line.	Branches and Spurs.							Iron.	Steel.
Total Mileage Operated (single track).										

C. — Mileage of Line Owned—by States and Territories (Single Track).

STATE OR TERRITORY.	Line Owned.			Total Mileage Owned.	New Line Constructed During Year.	Rails.		Remarks.
	Main Line.	Branches and Spurs.				Iron.	Steel.	
Total Mileage Owned (single track).								

Table 56.

RENEWALS OF RAILS AND TIES.

New rails laid during year.				New ties laid during year.		
KIND.	Tons.	Weight per yard. Pounds	Average Prise per ton at Distributing Point. Dollars.	KIND.	Number.	Average Prise at Distributing Point. Cents.
Iron						
Total Iron.						
Steel						
Total Steel.				Total.		

CONSUMPTION OF FUEL BY LOCOMOTIVES.

LOCOMOTIVES.	Coal tons.		Wood-Cords.		Fuel Oil-Gallons.	Total fuel Consumed-Tons.	Miles Run.	Average Pounds Consumed Per Mile.
	Anthracite.	Bituminous	Hard.	Soft.				
Revenue Service:								
Freight								
Passenger								
Mixed.								
Special								
Switching								
Non-revenue Service								
Total.								
Average Cost at distributing point								

Table 57.

ACCIDENTS TO PERSONS.

A. — *Accidents Resulting from the Movement of Trains, Locomotives, or Cars.*

KIND OF ACCIDENT.	Railway Employees.																Passengers.		Postal Clerks, Express Messengers, Pullman Employees, etc.		Other Persons.				Total.	
	Trainmen.		Switch Tenders, Crossing Tenders, and Watchmen.		Station men.		Shopmen.		Trackmen.		Telegraph Employees.		Other Employees.		Total.						Trespassing.		Not Trespassing.			
	Killed.	Injured.	Killed.	Injured.	Killed.	Injured.	Killed.	Injured.	Killed	Injured.	Killed.	Injured.	Killed.	Injured.	Killed.	Injured.	Killed.	Injured.	Killed.	Injured.	Killed.	Injured.	Killed.	Injured.	Killed.	Injured.
Coupling or Uncoupling																										
Collisions																										
Derailments																										
Parting of Trains																										
Locomotives or Cars breaking down																										
Falling from Trains, Locomotives, or Cars																										
Jumping on or off Trains, Locomotives, or Cars																										
Struck by Trains, Locomotives, or Cars																										
Overhead Obstructions																										
Other Causes																										
Total																										
Average Number Employed during Year																										

KIND OF ACCIDENT.	Passengers.		Postal Clerks, Express Messengers, Pullman Employees, etc.		Other Persons.						Summary. [Tables A and B.]	Total.	
					Trespassing.		Not Trespassing.		Total.				
	Killed.	Injured.	Killed.	Injured.	Killed.	Injured.	Killed.	Injured.	Killed.	Injured.		Killed.	Injured.
Collisions											Table B:		
Derailments											Railway Employees.		
Parting of Trains											Passengers.		
Locomotives or Cars breaking down											Postal Clerks, etc.		
Falling from Trains, Locomotives, or Cars											Other Persons		
Jumping on or off Trains, Locomotives, or Cars											Table A:		
Struck by Trains, Locomotives, or Cars	*	*	*	*	*	*	*	*	*	*	Railway Employees.		
At Highway Crossings											Passengers		
At Stations											Postal Clerks, etc.		
At other points along track											Other Persons		
Other Causes											Grand Total.		
Total													

B. — *Accidents Arising from Causes Other than Those Resulting from the Movement of Trains, Locomotives, or Cars.*

KIND OF ACCIDENT.	Railway Employees.										Passengers.		Postal Clerks express messengers, pullman employees, etc.		Other Persons.	
	Station men.		Shopmen.		Trackmen.		Other employees.		Total.							
	Killed.	Injured.	Killed.	Injured.	Killed.	Injured.	Killed.	Injured.	Killed.	Injured.	Killed.	Injured.	Killed.	Injured.	Killed.	Injured.
Handling Traffic																
Handling Tools, Machinery, etc.																
Handling Supplies, etc.																
Getting on or off Locomotives or Cars at rest																
Other Causes																
Total																

Table 58.

CHARACTERISTICS OF ROAD.

Working divisions or branches.			Alignment.			Profile.							
							Ascending Grades.			Descending Grades.			
From.	To.	Miles.	Number o Curves.	Aggregate Length of Curved Line.	Length of Straight Line.	Length of Level Line.	Number.	Sum of Ascents.	Aggregate Length of Ascending Grades.	Number.	Sum of Descents.	Aggregate Length of Descending Grades.	
				Miles.	Miles.	Miles.		Feet.	Miles.		Feet.	Miles.	

Table 59.

CHARACTERISTICS OF ROAD. (*Concluded.*)

BRIDGES, TRESTLES, TUNNELS, ETC.

Item.	Number.	Aggregate Length. Feet.	Minimum Length. Feet.	Maximum Length. Feet.	Item.	Number.	Height of Lowest above Surface of Rail. Feet.	In.
Bridges :					Overhead Highway Crossings:			
Stone					Bridges			
Iron.					Conduits.			
Wooden . . .					Trestles			
Combination . .					Total. .			
Total. .					Overhead Railway Crossings:			
Trestles . .					Bridges			
					Conduits.			
					Trestles			
					Total. .			
Tunnels . .					Tunnels.			

Gage of Track, ... Feet, ... Inches. ..... Miles.
[Miles.] [Hundredths.]

Ditto ..... Feet, ... Inches. ..... Miles.
[Miles.] [Hundredths.]

TELEGRAPH.

A. — OWNED BY COMPANY MAKING THIS REPORT.

Total.		Operated by this Company.		Operated by Another Company.		
Miles of Line.	Miles of Wire.	Miles of Line.	Miles of Wire.	Miles of Line.	Miles of Wire.	Name of Operating Company.

B. — OWNED BY ANOTHER COMPANY, BUT LOCATED ON PROPERTY OF ROAD MAKING THIS REPORT.

Miles of Line.	Miles of Wire.	Name of Owner.	Name of Operating Company.

Table 60.

FORM OF GENERAL BALANCE SHEET STATEMENT.

ASSETS.

Property Owned as Investment :

1. Physical Property Owned :

1-*A*. Road and Equipment to June 30, 1907 :
- *a*) Road ;
- *b*) Equipment.

1-*B*. Road and Equipment since June 30, 1907 :
- *a*) Road ;
- *b*) Equipment ;
- *c*) General Expenditures.

2. Securities Owned :

2. Securities of Proprietary, Affiliated, and Controlled Companies Pledged :
- *a*) Stocks ;
- *b*) Funded Debt ;
- *c*) Miscellaneous.

3. Securities Issued or Assumed-Pledged :
- *a*) Stocks ;
- *b*) Funded Debt ;
- *c*) Miscellaneous.

4. Securities of Proprietary, Affiliated, and Controlled Companies, Unpledged :
- *a*) Stocks ;
- *b*) Funded Debt ;
- *c*) Miscellaneous.

3. Investments :

5. Advances to Proprietary, Affiliated, and Controlled Companies for Construction, Equipment and Betterments.

6. Other Permanent Investments :
- *a*) Physical Property ;
- *b*) Securities.

Working Assets :

7. Cash.

8. Marketable Securities :

A. Securities Issued or Assumed-Unpledged :
- *a*) Stocks ;
- *b*) Funded Debt ;
- *c*) Miscellaneous.

B. Other Marketable Securities :
- *a*) Stocks ;
- *b*) Funded Debt ;
- *c*) Miscellaneous.

9. Loans and Bills Receivable.

10. Net Traffic, Car Mileage, and Per Diem Balance.

11. Net Balance Due from Agents and Conductors.

12. Miscellaneous Accounts Receivable.

13. Materials and Supplies.

14. Other Working Assets.

Deferred Debit Items :

15. Advances :
- *a*) Advances to Proprietary, Affiliated and Controlled Companies ;
- *b*) Working Funds ;
- *c*) Other Advances.

16. Insurance Premiums Paid in Advance.

17. Taxes Paid in Advance.

18. Discount on Securities Issued :
- *a*) Discount on Stock ;
- *b*) Discount on Funded Debt.

19. Property Abandoned, Chargeable to Operating Expenses.

20. Cash and Securities in Sinking and Redemption Funds.

21. Cash and Securities in Insurance and Other Special Funds.

22. Cash and Securities in Special Trust Funds.

23. Items in Suspense.

Deficit :

24. Profit and Loss-Balance.

Note. — This is a tentative balance sheet to be used in lieu of Table 41.

Table 61.

LIABILITIES.

Stock :

25. Capital Stock :
    - *a*) Common Stock;
    - *b*) Preferred Stock;
    - *c*) Debenture Stock.
26. Receipts Outstanding for Capital Stock.
27. Stock Liability for Conversion of Outstanding Securities of Constituent Companies.
28. Premium Realized on Capital Stock Sold.

Mortgage, Bonded, and Secured Debt :

29. Funded Debt :
    - *a*) Mortgage Bonds;
    - *b*) Collateral Trust Bonds;
    - *c*) Plain Bonds, Debentures, and Notes;
    - *d*) Income Bonds;
    - *e*) Equipment Trust Obligations;
    - *f*) Miscellaneous Funded Obligations.
30. Receipts Outstanding for Funded Debt.
31. Premium Realized on Funded Debt Sold.
32. Receivers' Certificates.
33. Obligations for Advances Received for Construction, Equipment, and Betterments.

Working Liabilities :

34. Loans and Bills Payable.
35. Net Traffic, Car Mileage, and Per Diem Balance.
36. Audited Vouchers and Wages Unpaid.
37. Miscellaneous Accounts Payable.
38. Matured Dividends, Interest, and Rents Unpaid.
39. Matured Mortgage, Bonded, and Secured Debt Unpaid.
40. Working Advances Due to Other Companies.
41. Other Working Liabilities.

Accrued Liabilities not Due :

42. Dividends Declared and Interest and Rents Accrued, not Due.
43. Taxes Accrued.

Deferred Credit Items :

44. Operating Reserves :
    - *a*) Reserves for Replacement of Property;
    - *b*) Reserves for Other Purposes.
45. Liability on Account of Special Trust Funds.
46. Items in Suspense.

Appropriated Surplus :

47. Surplus Reserves :
    - *a*) Reserves Invested in Sinking and Redemption Funds;
    - *b*) Reserves Invested in Insurance and Other Special Funds;
    - *c*) Reserves Not Specifically Invested.
48. Additions to Property through Income since June 30, 1907.

Free Surplus :

49. Profit and Loss-Balance.

Note. — This is atentative balance sheet to be used in lieu of Table 42.

Table 62.

OUTSIDE OPERATIONS : FERRY LINES

OPERATING REVENUES.

General Accounts.

I. — Passenger Revenue.

II. — Vehicle and Live Stock Revenue.

III. — Charters.

IV. — Miscellaneous Revenue.

OPERATING EXPENSES.

General Accounts.

Account :

I. — Maintenance.

II. — Transportation Expenses.

III. — General Expenses.

PRIMARY ACCOUNTS.

I. — Maintenance :

1. Dredging.
2. Buildings, Fixtures and Grounds.
3. Docks, Float Bridges, and Ferry Racks.
4. Telegragh and Telephone Lines.
5. Ferryboats : Repairs.
6. Ferryboats : Renewals.
7. Ferryboats : Depreciation.
8. Shop Machinery and Tools.
9. Injuries to Persons.
10. Other Expenses.
11. Maintaining Joint Facilities : Dr.
12. Maintaining Joint Facilities : Cr.

II. — Transportation Expenses ·

13. Superintendence.
14. Shore Employees.
15. Supplies and Expenses : Shore.
16. Telegraph and Telephone Operation.
17. Charter of Boats.
18. Manning Boats.
19. Fuel for Boats.
20. Water for Boats.
21. Other Supplies and Expenses : Boats.
22. Loss and Damage.
23. Damage to Property.
24. Injuries to Persons.
25. Other Expenses.
26. Operating Joint Facilities : Dr.
27. Operating Joent Facilities ; Cr.

III. — General Expenses :

28. Administration Expenses.
29. Law Expenses.
30. Insurance.
31. Relief Department Expenses.
32. Pensions.
33. Stationery and Printing.
34. Other Expenses.
35. General Administration, Joint Facilities : Dr.
36. General Administration, Joint Facilities : Cr.

Note. — Table 62 covers outside Operations, the Earnings and Expenses of which are kept under a separate classification.

MONTHLY REPORT OF REVENUES AND EXPENSES. APPENDIX B.

Full Name of Company making this Report : .....

Year ending June 30, 1909		ITEM.	Year ending June 30, 1910.		Increase (or decrease).	
February, 1909.	Total for July 1, 1908, to February 28, 1909.		February, 1910.	Total for July 1, 1909, to February 28, 1910.	For the month.	For the period.
		Rail Operations :				
		Freight Revenue (Account 1).				
		Passenger Revenue (Account 2).				
		Other Transportation Revenue (Accounts 3 to 11).				
		Non-transportation Revenue (Accounts 12 to 21) .				
		Total operating Revenues				
		Maintenance of Way and Structures				
		Maintenance of Equipment				
		Traffic Expenses.				
		Transportation Expenses.				
		General Expenses				
		Total operating Expenses				
		Net operating Revenue (on Deficit). . .				
		Outside Operations :				
		Total Revenues				
		Total Expenses.				
		Net Revenue (or Deficit)				
		Total Net Revenue (or Deficit). . .				
		One-twelfth of Annual Taxes.				
		Operating Income (or Loss)				

Miles of Line Operated : On February 28, 1909, ... *On February 28, 1910,* .....
(Single track.) (Miles.) (Hundredths.) (Miles.) (Hundredths.)

Here follows the oath required by law as to the correctness of the report.

APPENDIX C.

Condensed Classification of Operating Expenses used by many railways in the United States. The larger systems use a more detailed classification with 116 primary accounts.

I. MAINTENANCE OF WAY AND STRUCTURES :

1. Superintendence.
2. Maintenance of Roadway and Tracks.
3. Maintenance of Track Structures.
4. Maintenance of Buildings, Docks, and Wharves.
5. Injuries to Persons.
6. Other Maintenance of Way and Structures Expenses.

Total of Accounts Nos. 1 to 6.

7. Maintaining Joint Tracks, Yards, and Other Facilities—Dr.
8. Maintaining Joint Tracks, Yards, and Other Facilities—Cr.

Total—Maintenance of Way and Structures.

Ratio to Total Operating Expenses (per cent).

II. MAINTENANCE OF EQUIPMENT :

9. Superintendence.
10. Locomotives—Repairs.
11. Cars—Repairs.
12. Floating Equipment—Repairs.
13. Work Equipment—Repairs.
14. Equipment—Renewals.
15. Equipment—Depreciation.
16. Injuries to Persons.
17. Other Maintenance of Equipment Expenses.

Total of Accounts Nos. 9 to 17.

18. Maintaining Joint Equipment at Terminals—Dr.
19. Maintaining Joint Equipment at Terminals—Cr.

Total—Maintenance of Equipment.

Ratio to Total Operating Expenses (per cent).

III. TRAFFIC EXPENSES :

20. Traffic Expenses.

Ratio to Total Operating Expenses (per cent).

IV. TRANSPORTATION EXPENSES :

21. Superintendence and Dispatching Trains.
22. Station Service.
23. Yard Enginemen.
24. Other Yard Employees.
25. Fuel for Yard Locomotives.
26. All Other Yard Expenses.
27. Operating Joint Yards and Terminals—Dr.
28. Operating Joint Yards and Terminals—Cr.
29. Road Enginemen and Motormen.
30. Fuel for Road Locomotives.
31. Other Road Locomotive Supplies and Expenses.
32. Road Trainmen.
33. Train Supplies and Expenses.
34. Injuries to Persons.
35. Loss and Damage.
36. Other Casualties.
37. All Other Transportation Expenses.
38. Operating Joint Tracks and Facilities—Dr.
39. Operating Joint Tracks und Facilities—Cr.

Total—Transportation Expenses.

Ratio to Total Operating Expenses (per cent).

V. GENERAL EXPENSES :

40. Administration.
41. Insurance.
42. Other General Expenses.

Total of Accounts Nos. 40 to 42.

43. General Administration Joint Tracks, Yards, and Terminals—Dr.
44. General Administration Joint Tracks, Yards, and Terminals—Cr.

Total—General Expenses.

Ratio to Total Operating Expenses (per cent).

Total—Operating Expenses.

Ratio of Operating Expenses to Operating Revenues (per cent).

SECTIONAL DISCUSSION

Meeting held on 6 July, 1910 (morning).

MR. EVELYN CECIL, VICE-PRESIDENT, IN THE CHAIR.

The President. (In French.) — Mr. Acworth, reporter for Great Britain, will adress the meeting.

Mr. Acworth, *reporter.* — As I appear here as one of the delegates appointed by the British Board of Trade, I ought to say at the outset that the Board of Trade has no responsibility for my report. I was invited by the permanent Commission of Congress to act as a reporter long before I was appointed a delegate by the Board of Trade, and my report is made wholly in my personal capacity. I may say further I sent no *questionnaire* to the companies because, as it seems to me, it was the published statistics alone that concerned an International Congress, for they are the only statistics that can be used for comparative purposes.

I have said that in Great Britain there are no principles of statistics, and there is no uniform classification of expenses. For a long time past complaint has been made both of the insufficiency and of the inaccuracy of the statistics that are published. The responsibility for the present state of affairs rests mainly with the government, which as long ago as 1868 prescribed by Act of Parliament in precise detail the statistics that should be furnished by the companies. In the year 1906, the Board of Trade appointed a Committee, of which I had the honour to be a member, to consider what alterations should be made in the published accounts and statistics of the English railway companies. The new forms proposed by this committee will be found annexed to my printed report. It will be observed that no attempt has been made in them to bring the classification of working expenses into conformity with those in use in other countries. Undoubtedly in my judgment it would have been desirable to do so. But the committee found it impossible: to do so would have meant breaking with the whole past history of English railways, and so radical a step could hardly be made without the active support of the railway companies — support which they were not disposed to give.

As an example, let me give the locomotive accounts. Whereas, in almost every other country the cost of traction appears as one head of cost of operation, in Eng-

land this has always been given, and will continue to be given, in a separate account.

The matter most discussed by the Board of Trade Committee was the question whether the railway companies should be required to furnish ton mile and passenger mile statistics : whether, in other words, record of the length of haul, as well as of the number of tons and passengers hauled, should be recorded. The English companies claim that this information, which of course is given almost everywhere else in the civilized world, is of no value in England. The Committee was divided on this subject. It pronounced by a majority of six to three that this information was valuable. But, in view of the opposition of the railway companies, only three members out of nine were in favour of making it compulsory to furnish the information.

In appendix II of my report will be found tables proposed by the minority to give effect to their recommendations in favour of the publication of ton mileage and passenger mileage.

Appendix I contains the unanimous recommendations of the committee. In view of the fact that the committee which was representative of all classes of opinion was so far unanimous, and that these recommendations have been accepted by the Board of Trade in their entirety, there is every prospect that they will be accepted by Parliament as they stand. A bill for that purpose has been already introduced, and, if and when it passes, the forms in appendix *B* will become the statutory form for accounts and statistics for all the railway companies in the United Kingdom.

The President. (In French.) — Before I pass to the summary of the next report, several of my English colleagues have requested me to recall what Mr. Acworth mentioned at the beginning of his speech, namely that he did not speak as representing the Board of Trade, but in his own proper name.

Mr. Acworth took care to mention this himself, so as to avoid any misunderstanding. Besides, that is the rule here : the reporters give, in their own name, the summary of the information they have collected and make their own personal remarks, but they do not speak in the name of the government or of the country they represent.

As the reporter for the British colonies is absent, I request Mr. Appleyard kindly to give us a summary of Sir Thomas Rees Price's report.

Mr. Appleyard, Central South African Railways. — Sir Thomas Rees Price's report deals with the question of statistics in the British colonies, excluding Canada which has adopted the American system, but including South Africa and Australia.

Unfortunately the Australian railways did not supply the information necessary to make it possible to give an accurate description of their method of work.

The book-keeping of the South African railways much resembles the American book-keeping.

Sir Thomas Rees Price in the first place recognizes that the adoption, by all the railways, of uniform methods for their statistics and traffic returns would be of an inestimable advantage to the organization and administration of railways. It is, however, too much to hope for absolute

uniformity in these statistics now and Sir Thomas Rees Price would like the deliberations of the Congress to result in the future adoption of a standard type, accepted by all the members, for the accounts and the classification of working expenses of railways.

Sir Thomas Rees Price then analyses the principles adopted by the different dministrations of the British colonies, in their statistics.

His report shows that most of the statistics generally drawn up by railways in the British colonies belong to one of the following two classes :

1° Tables or statements (including those giving approximate figures) prepared very soon for the immediate use of the heads of the executive services of the administrations;

2° Statistics of a more permanent character, which usually require longer time for preparation and which are sometimes less useful as regards the organization of the ordinary details of working than as regards the examination of general results and of their tendencies, so as to serve as guide to the administration in considering general administrative and financial questions.

As regards working expenses, Sir Thomas Rees Price records that there is no uniformity in the classification of those expenses adopted by the railways in the British colonies. He thinks that it would be an advantage if the British colonies and the railways in the whole world came to an agreement as to the method of dealing with the expenses connected with :

a) Replacements;

b) Improvements;

c) Capital purposes;

d) Accessory services (for instance catering) in connection with the railways.

The real test of the value of statistics of one class or another is their utility. Sir Thomas Rees Price is of opinion that the statistics of a more permanent character would be of much greater value if, in the interests of uniformity, all the administrations belonging to the Congress came to an agreement about certain points, such as the method of calculating open mileage, train mileage, vehicle mileage, ton mileage, etc. The standardizing of the principal statistical returns and the establishment of a recognized classification, approved by the Congress and adopted generally, would add considerably to the value of the statistics of the different railways and would enable the results obtained by different administrations to be compared.

I have a certain number of papers in my possession which I will with much pleasure submit to those interested in the subject.

The President. (In French.) — As the reporter for America is absent, Mr. Patterson, superintendent of freight transportation, Pennsylvania Railroad, will kindly give a summary of Mr. County's report.

Mr. Patterson, Pennsylvania Railroad. — As Mr. County is unfortunately prevented from attending the meeting, I take his place in order to give you a brief summary of his report. I regret that I am no statistician and hence unable to give details of the different points concerned. But there are present at this meeting a number of eminent American statisticians who will be able to fill this

gap, during the discussion. Mr. County, in this report, comes to the conclusion that the necessity and the advantages of a uniform system of statistics or accounts have become so very apparent during the last ten or twenty years that there can henceforth be no difficulty in imposing, both on weak and on strong roads, and on those companies which must observe special charter requirements, the obligation of keeping certain definite accounts. The different considerations referring to rails and installations set forth in Mr. County's report may serve to make this clear.

The necessity and the advantage of a uniform system of accounts and statistics have for a long time been recognized in the United States. Congress in this connection issued prescriptions by which the Interstate Commerce Commission received the power to enforce very strictly the observance of the legal forms it prescribed. An agreement was come to between the commission and the companies and uniform regulations were adopted applying to all railways.

The reporter believes that no statistics applying to any given point can give useful information without others to supplement and correct it, so as to tell the whole story of all the branches of the service; and general experience upholds this opinion.

No matter how statistics may be prepared, they will always require, in order that they may be interpreted in a comprehensive and intelligible form :

1° Personal knowledge of the traffic and of the working conditions, on the part of those who compile them;

2° Quickness in compiling them, so that they may reach the operating, traffic and administrative officers within a relatively short period after the operations have taken place. This can only be done if there is proper co-operation of the traffic, the operating and the auditing officers;

3° A separation, in each set of statistics, between the facts subject to the control of the operating officer, head of the service for the needs of which this set of statistics is compiled, from those over which he has no control, or only partial control; with a clear definition of both sets of statistics;

4° Finally, however well-founded the desire of railway officers and of the government to obtain a system of uniform accounting may be, this desire must not lead them to prevent wise and prudent measures by arbitrary decisions, like those which strip operating expenses of everything except bare maintenance charges and force all above that into the capital account.

The President. (In French.) — Mr. Bloch, principal secretary of the section, will kindly give a summary of Mr. Barriol's paper, as the latter is absent.

Mr. Bloch, *principal secretary*. (In French.) — Mr. Barriol had to study the question of statistics, as regards all countries, excepting those using the English language. His report, which is very comprehensive, starts with asserting the importance of statistics in establishing an equilibrium between the receipts and expenses. He proposes to divide statistics into four groups :

1° Statistics of cost of establishment, financial resources, charges;

2° Statistics of revenue;

3° Statistics of expenditure, and
4° Various statistics.

As regards the first, Mr. Barriol recommends the following subdivisions :

a) *Installation of lines, including :*

1° General expenses, general costs of management, of central administration, etc. ;
2° Purchase of lands, expropriations, law expenses, etc. ;
3° Earthwork, constructional works ;
4° Permanent way and ballast (materials) ;
5° Station buildings, workshops, stores, depots, telegraphic installations, etc. ;

b) *Rolling stock* ;
c) *Tools and appliances* ;
d) *Stores* ;
e) *Financial resources* ;
f) *Charges* (interest, redemptions, accessory expenses, etc.).

As regards statistics of revenue, Mr. Barriol thinks they should be classified as follows :

a) " *Grande vitesse* " *receipts*, divided into special categories : *passengers* (by class, character of train and rates) ; *luggage*, *dogs*, *cash*, *postal packets*, *horse*, *cattle*, and finally, " *grande vitesse* " *goods*, divided into special categories ;

b) " *Petite vitesse* " *receipts* ; as regards these he thinks the differentiation of the goods can be carried out very fully ;

c) *Miscellaneous receipts* : produce of estates, of lands not utilized, stations held in common with other companies, letting of rolling stock, investments, etc. ;

d) *Statistics of revenue per station and line.*

Passing to the *statistics of expenditure*, Mr. Barriol gives the following five principal heads ; central administration ; working properly so-called ; movement and traffic ; locomotives and rolling stock ; maintenance of way and works. But he recognizes that in practice it is difficult not to come into line, in each railway, with the great administrative questions. He adds that it is difficult to arrive at any international classification, as even in countries like France, where a given system has been specified by the higher authorities, there are differences in detail in dealing with certain articles.

Mr. Barriol would also desire a certain number of detailed statistics to be drawn up for :

Mileages of locomotives, of trains, of vehicles, of staff ;

Average composition of trains of different kinds, utilization of rolling stock ;

Expenses per kilometre of train, of locomotive, of vehicle ;

Accidents, delays, etc. ;

Superannuation funds, pensions, etc.

Finally, Mr. Barriol concludes as follows :

To sum up, it will be found that statistics do not occupy, in the case of railway systems as a whole, the position to which they are entitled.

Sufficient account does not appear to be taken of the importance of the services which they render, whether by immediate utility in connection with the accidental variations of traffic, of internal working, etc., or by retrospective returns which indicato the general progress of affairs.

It would be puerile to keep statistics for the mere pleasure of setting up tables of figures, but all those which we have indicated

have a definite purpose, and will be of service, directly or indirectly, in acquainting the directors or heads of departments with the results of the working, and the utility of the means adopted to secure the efficacy of the services.

From a purely statistical point of view, it would be advisable that the returns should be presented in analogous form by all the administrations, with a view to facilitating comparisons.

Should such a step be determined upon, it would be necessary to proceed methodically, commencing with the unification of the general returns serving as bases for the appointments : length of lines, mileages of trains, of vehicles, of axles, etc., that is to say, with the statistics which I have named auxiliary.

As regards the uniform classification of working expenses, it would appear very difficult to arrive at an understanding, since in countries like France, where under a general scheme prescribed by the superior authorities, one notices considerable differences of interpretation. At the most, one can only recommend a classification on the lines of the great administrative divisions : general services, internal and general traffic, locomotives and rolling stock, maintenance of way and works.

Having given this summary of Mr. Barriol's interesting work, I request the President to allow me to speak, in my own name, about a subsidiary question. The very interesting reports brought to our notice seem to me to consider the question from the point of view of the external statistics, that is to say, from the point of view of the relations between the companies and the shareholders, the public authorities and the economists ; but there is one side of the question which has been omitted, namely that of the internal statistics.

Statistics give the companies a powerful and interesting means for following the working of the services and for enabling the heads of the departments to intervene effectively in order to ensure the proper progress of the work.

I was entrusted with drawing up the report on the question of perishables, and I was surprised to find, in answer to my question as to the results of this traffic, that certain railways, and those by no means smaller ones, declared that they had no statistics.

That seems to me a very extraordinary state of affairs; for a service which works without statistics seems to me like a blind man who does not see where he is going.

Independently of the commercial service, statistics are also an excellent means for checking expenditure.

We will all agree in saying that as a rule railways employés are selected men, that in most cases the employés have every wish to obtain the best possible results, in the first place because they have a feeling of the responsibilities of their duties, in the second because they wish not to call for remark.

But what sometimes prevents them from obtaining good results, is the lack of sufficient information.

Well ! the road to success is to be found in the statistics.

In this connection I can quote two very interesting instances.

Some fifteen years ago, the Orleans Railway started using tables giving for each station, in a very summary form, particulars of the work as well as of the cost of the staff.

The results surpassed all expectations, and we were surprised to find that an

immediate stop in the expenditure of the station staff followed the institution of these tables. Not only was the growth of expenditure abated or stopped, but there were even cases of reduction.

I think, moreover, that this result is due much more to the influence of the station staff itself on its own action than to the control of the head authorities.

The staff has in fact in this way been given information which has enabled it spontaneously to introduce improvements in the service.

We have obtained just as interesting results as regards absence on account of sickness. Among our employés who are generally, as I have already stated, selected men, there are, however, as everywhere, some who are less conscientious. On our railway, full pay is given during days of illness, and there are some doctors who tend to grant an undue length of time of rest to any sick or injured employés. Some years ago, we began to compile statistics of the days of rest granted by each doctor to the sick in his district; and where the average was exceeded we wrote to ask for the reasons for these absences of abnormal duration.

This simple demand for information sufficed to correct the abuses in question and to lead to a diminution in the number of days of rest. Thus the mean number of these days which was 5·9 in 1907, dropped to 5·5 in 1908 and to 5·3 in 1909.

That is a very appreciable result; and accordingly I think that it would be well to extend our studies and investigations to these internal statistics, and I therefore propose to you to adopt the following resolution :

" It is desirable that the investigation and comparison of the statistical methods used by the railway administrations in order to control the work of their employés should be a subject for discussion at one of the next sessions of the International Railway Congress. " (*Applause.*)

Mr. Ftolof, Moscow-Vindau-Rybinsk Railway. (In French.) — Sir Thomas Rees Price, in his report, draws attention to the importance of the division of the expenses between the passenger and the goods services. This is a very difficult problem, perhaps an insoluble one; and all the solutions proposed are based on purely arbitrary assumptions.

I request the permission of the section to bring before them the results I have obtained by applying the theory of probability to this question.

With this object in view, I took the statistics of twenty-five of the Russian lines for a period of three years before the Russo-Japanese war, and I assumed that the total expenditure of each line depended on the following five factors : the length of the line, the number of passenger-train-kilometres, the number of goods-train-kilometres, the number of passenger-axle-kilometres, the number of goods-axle-kilometres.

Applying to these statistical data the method of least squares, I obtained the following results :

The working expenses which do not depend on the train mileage were found to be very small, about 1,000 or 2,000 francs on the average per kilometre (£64 or £128 per mile), out of 30,000 or 40,000 francs of total expenses per kilometre (£1,931 or £2,575 per mile). This result is quite in agreement with the ideas

adopted by Messrs. Colson and Marlio in their investigation of the net cost of extra transportation in the case of the growth of a *regular and important* traffic.

I next found that the net cost of an axle-kilometre was twice as high in the case of passenger trains as in that of goods trains.

I must, however, add that this method cannot be applied when it is a question of a separate railway; but by applying it to a sufficiently large group of railways, as homogeneous as possible, although with traffics of different densities, it seems to me that it will be possible to deduce in each case the rule which will give the basis for the division of the expenses between the passenger and the goods services, even in the case of an individual railway system.

Mr. Timonoff, *vice-president*. (In French.) — I ask to be permitted to draw the attention of the section to two institutions which are of interest from the point of view of railway statistics. In the first place, there is the *Institut international de statistique* which, on the proposal of one of its members, General de Wendrich, who was under-secretary of State at the ministry of ways of communication at St. Petersburg, has appointed a special commission for investigating the question of the statistics of international transports. The work of this commission may prove of great interest to our Congress.

Secondly there is the *Office central des transports internationaux*, at Berne, which instigates the meeting of international conferences; and at one of these conferences it was decided to investigate thoroughly the question of the unification of railway statistics. With this object in view, the Swiss Federal government has entered into diplomatic relations with all countries, two or three years ago already, and at the present time the question of calling a special conference, having as object the unification of railway statistics, is under consideration.

While the work of the *Institut de statistique* is of general and theoretical interest, this is not the same in the case of the work of the conference just mentioned. This conference aims at an object which we all have in view, a practical object.

Railway statistics are not a theoretical science; they are a science which strives to give as accurate information as possible to the railway administrations, in order to make it possible to draw the greatest possible amount of usefulness out of this system of transportation.

The International Railway Congress Association should contribute as much as it can towards the good success of this enterprise, and accordingly I have the honour to propose to you the addition of the following special resolution to the conclusions which you will adopt :

" It is desirable that the initiative already taken hy the Swiss Federal government in calling a special international conference having as its object the unification of railway statistics should result in the establishment, in as short a time as possible, of railway statistics making it possible readily to compare at least the chief principal elements of the working of railways in the different countries. "

Mr. von Zluhan, Wurtemberg State Railway. (In German.). — What you have heard shows beyond doubt that good and

exact railway statistics are of great importance : firstly, to the railways themselves; secondly, to political economy generally. They are certainly one of the most important tests of the economic situation of the different countries. But in order that those statistics may be used for this purpose, it is necessary that the different railway administrations should be able to compare their results with those of other administrations, and if necessary to modify their organization so as to obtain equally favourable results or eliminate unfavourable factors; consequently the statistics must have essentially the same basis. It will be difficult, it is true, to compare from this point of view the railways owned by the State and those owned by private companies.

In Germany, the system of the State railways is by far the most important; but side by side with this there are some privately-owned railways of a certain importance. On the latter, the financial results are of course considered the most important feature, while the State railways, although they attach considerable importance to the working coefficient, can consider, besides the financial results, also the functions and uses of the railways in public life generally.

It has just now been remarked that in more than one country the railway statistics have no uniform basis, or at least that it would be useful to improve that basis. In this respect I may mention that the situation is different in Germany. We have one standard type of statistics for all the German railways. This type includes thirty-two extensive tables. I will only mention the most important ones to you. The tables contain uniform information about : the conditions of ownership and the length, particulars of the profile and the plan, the formation level and the superstructure, the telegraph and signal installations, the number of stations, constructive works and other structures, the maintenance and renewal of the track, the cost of maintenance, of renewal of new constructive works, the number and cost of construction of the vehicles, the locomotives, the passenger carriages, the luggage vans and the goods wagons. They also contain information about the mileage of the rolling stock, the passenger traffic and the goods traffic, the original cost and the expenditure on insurance against sickness and the grants made to employés in cases of accidents while at work and of incapacity. Finally, the financial results, the receipts and expenses, are given in detail. There are also, for all the German railways, standard book-keeping regulations concerning receipts and expenses.

Just as in the case of the *German* railways, we have uniform statistics for the *Verein* which, as you know, includes not only the German railways, but also the Austrian and Hungarian State railways and some other lines in connection with Germany, Austria and Hungary. These statistics also include, under five or six principal headings, like the German railway statistics, all the important particulars relating to the operation of the railways, the receipts and the expenses.

These statistics afford us very valuable assistance; they offer the advantage that they make it possible for all the German railways and all the *Verein* railways to compare their results together accurately.

I thus arrive, like the previous speaker,

at the conclusion that general statistics, common to all the railways, drawn up as specified by the Permanent Commission, are to be recommended, for as I have already said, they will enable the administrations accurately to compare their working conditions with those of other railways and to make modifications and improvements in their system of working.

In order to make such a comparison possible, it is necessary for the statistics to have a common basis, as far as the most essential points are concerned. Perhaps, if I may venture to make the suggestion, the German railway statistics might supply a suitable basis. Moreover, statistics will best allow the comparison of the conditions of the different administrations, if it is based, as far as possible, on statistical railway units.

Then also much importance must be attached to the regular and quick publication of the statistics, for they can only be really useful if this double condition is observed.

Sir Charles Owens, London & South Western Railway. — It gave me great satisfaction to find this important subject included in the programme of the Congress. No railway administration can attempt to carry on its business without adequate and proper statistics, but my personal experience forces me to the conclusion that statistics which might be of primary importance in one country were not at all necessary or of any importance in another country. I do not believe it possible to obtain a uniform system of statistics for all railways. I agree with what has been stated in the reports of Mr. County and Sir Thomas Rees Price.

With regard to the ton mile, it was stated before a committee twenty-five years ago by Mr. Grierson, than whom England had had no more experienced or able railway manager, that as regards the ton mileage statistics they had been tried for years and found unsuitable to English conditions and therefore absolutely useless. For that reason they were abandoned. These statistics have been tried not only by the Great Western Company, with which Mr. Grierson was associated, but by the London & North Western Company, and both companies abandoned them as being useless for the purpose of reflecting the working conditions on English railways. It is possible to have too many statistics, and I myself have had experience of keeping statistics which were never used.

Another consideration is that statistics when applied by the ill-informed are inevitably misleading. It is necessary when attempting to apply detailed statistics that they should be handled by a practical man to whom the conditions of working are known. In connection with American railroads, there is a restriction upon the amount which may be charged to revenue for betterment purposes. In England, on the other hand, nearly every company has a specific sum below which all improvements in the line are charged to revenue. In the case of the London & South Western Company, all improvements, which cost less than £200 are paid out of revenue, and some companies pay amounts up to £500 out of revenue. English railway companies recognize the broad principle that improvements up to a certain amount ought to be borne, not by capital, but by revenue, and I think this is a sound financial policy.

The question of the ton mile was discussed at great length before a meeting of the Railway Accountants' Association in London. It was thought that the ton mile might prove a basis for making rates, but when it was pointed out that the average rate per ton of millinery and coal would hardly give you a fair basis to decide upon the rate for steel rails, that idea died.

I must now turn to Mr. Acworth's paper. Mr. Acworth is an old friend of mine, and I hope that he will forgive me if I say anything which is unkind, but I am compelled to say a few words in vindication of English railway practice after the charges made by Mr. Acworth in his report. Mr. Acworth says he does not represent the Board of Trade, and he certainly does not represent British railway companies, so that I am forced to the conclusion that Mr. Acworth represents Mr. Acworth. Mr. Acworth starts by saying that in the United Kingdom there are no principles of statistics of railways in operation. The truth is that Mr. Acworth has a liking for one particular set of principles, and because he does not find them he assumes there are no principles, much in the same way as a man who with a liking for geraniums, going into a garden and finding only roses blooming, comes back and says there are no flowers in the garden. How does his statement that there are no principles of statistics in operation, reflect upon the Board of Trade who have the power to insist upon statistics? How does it reflect upon the eminent commercial men who form the Boards of Directors of railway companies, and how does it reflect upon the practical railway men who have grown up in the work, and know its needs? It is preposterous to state that there were no principles in railway accounting. I must appeal to the statement in Mr. Acworth's own report, in which he says that in the year 1868 an Act of Parliament was passed which requires all railway companies to prepare and publish half year by half year a report with accounts and statistics according to forms laid down in detail by the Act itself. To say that statistics of that sort could be produced and blue books compiled by a system in which there are no principles was to say what is, to my mind, an apparent absurdity.

Then again Mr. Acworth talks about maintenance-of-way expenditure being subdivided under four heads, and he quotes a statement made by the chief engineer of my own company that it is a matter of pure accident under which of those heads any particular item is put. The statement to which he alluded was made in a lecture delivered to the railway students of the London school of Economics, and in that same lecture the lecturer referred in some detail to the care exercised in the compilation of railway accounts. The lecturer said :

> Such principles as the above can be, and are being followed most carefully and with the most satisfactory results by British railway companies. Every unit of responsibility from which expenditure originates, whether it be the working party under a supervising foreman, engaged upon the maintenance of a section of railway, or whether it be the office of the head of the department, is classified as the whole or part of an accounting group. If a part only, there will be a further sub-classification. From these foundations figures upon which the whole account is built, right up to the total summary every item of expenditure will be in this way traceable to its own class

and sub-division of a class. Every item of expenditure as it arises whether for wages, engine power or material (the three main divisions of expenditure) appears on a voucher that requires acceptance and appropriation at the hands of one or other of the classes and of one of the sub-divisions of a class representing individual responsibility.

Does a system of this kind give the impression that the particular head under which an item is placed is a matter of pure hazard? To make a statement of that sort is as unfair as it is unsubstantiated. It is a matter of regret that when it was decided to ask somebody to report upon British railway practice, the committee in its wisdom did not select an accountant officer of one of the great railway companies, who would have given a report based upon proper knowledge of the conditions. Mr. Acworth is the last man in the world to deliberately mislead people, but although Mr. Acworth is a very clever amateur he is only an amateur, and in matters of detail he is often absolutely and entirely wrong. Mr. Acworth made a reference to hotels. He said that the revenue receipts and expenditure from hotels did not appear under the head of traffic receipts and expenditure, but was entered separately as " Miscellaneous ". That is not the case. These items, or rather the profit derived from the working of the hotel, are entered in the accounts as rent. Then again Mr. Acworth referred to the manner in which merchandise traffic was dealt with. Mr. Acworth says that on English railways the rates for merchandise traffic normally include not merely railway carriage, but collection from the consignor and delivery to the consignee, no separate charge being made for these latter services. That statement is true to a certain extent, but it is very untrue in some respects when analysed. The great bulk of such traffic on English railways is carried at special rates, rates below the classed rates, and almost universally that does not include collection and delivery. Then again in the case of Liverpool traffic it includes collection and delivery at one end, but not at Liverpool. Mr. Acworth made these mistakes because he did not know the actual working conditions.

Then in referring to the committee which had these matters under consideration he stated that of these nine members three were railwaymen, who would make up their minds so that the result in their case was a foregone conclusion. I wish to say that the English railwaymen went into the subject with perfectly open minds, and as a matter of fact every witness coming before the committee was asked to give an illustration of the benefits to be derived from ton mile and passenger mile statistics.

Speaking as a railway man myself, I wish to say that my mind was perfectly open on the subject, and if any man could convince me that benefit would follow the adoption of ton mile or any other form of statistics I should gladly adopt them. This question of ton mile statistics is a purely domestic concern. If American railways find such statistics useful it is not for me to criticise their action, and I believe that my American friends would agree with me that if English railway companies find no useful purpose served by such statistics they will not be disposed to criticise their action.

Meeting held on 6 July, 1910 (afternoon).

MR. COLSON, PRESIDENT, IN THE CHAIR.

The President. (In French.) — We will resume the discussion of subject XIV.

Mr. Sam Fay, Great Central Railway, Great Britain. — Like Sir Chas. Owens I also am one of Mr. Acworth's friends and I must ask him to take anything I may say in that light, but the profound conviction has been forced upon me that the time he has devoted to ton-mile statistics would have been far better employed in the propagation of snakes in Ireland.

The English railwayman has a natural and fundamental objection to ton-mile statistics for the reason that under English conditions they would describe the thing that is not.

In countries where the railways are under the State, and therefore in the hands of a single administration, or upon systems where there is little, if any, of the complications to be found in England, ton-mile statistics show the average charges per ton per mile, and give some idea, at any rate, of the cost per ton per mile on an average (for what such average is worth) of a miscellaneous collection of things whereof the bulk and weight bear no relation the one to the other.

It has been airily stated that the question of division of receipt and cost as between companies, interwoven as they are in England, may be left to the Accountants to adjust, but the infinite variety and the immense volume of merchandise passing over various ownerships in trains belonging to companies other than such ownerships, renders it a matter of impossibility to produce ton-mileage which can in any way be made to represent the charge per ton per mile as paid by the public, or indicate in the remotest degree the cost per ton per mile to the company hauling the traffic or the company owning each particular section of the line.

To illustrate the complexity of the interworking as between English railway companies, more particularly in the principal industrial centres, and where as a consequence the tonnage is heaviest, I will give two examples of the division of the receipts on throughout trains :

Train No. 1 commences its journey at a depôt owned by Company *A* running the train. It then passes on to the line of a dock company, for which a toll of one shilling per wagon is paid. Then on to Company *B*'s line, 1 mile 30 chains in length, with a fixed toll of 3*d*. per ton to the owning company irrespective of the rate per ton for the traffic conveyed; then over 19 miles 43 chains on Company *A*'s own line, the whole of the receipts being of course received. Next for 30 miles 30 chains over Company *C*'s line, one-third ownership of which is held by Company *A*, with engine and guard allowance varying with the price of coal at the pit's mouth. Then over 67 chains of Company *D*'s line with half-ownership to Company *A*, and half the residue after allowing 20 per cent, to Company *C*. Thence over

another piece of Company *C*'s line 10 miles 75 chains long owned in thirds. Next by running powers over Company *E*'s line 29 chains with toll of 0·325 of a penny per ton. Next over 2 miles 16 chains of Company *C*'s line, then over Company *A*'s line for 34 miles 44 chains. Then by running powers over 15 miles 23 chains of Company *F*'s system with an allowance of 40 per cent, and finally, over 4 miles 44 chains of Company *G*'s railway by running powers at 33 $^1/_3$ per cent of the throughout rate. A total of 120 miles 1 chain over eight different ownerships and eight varying methods of division of receipts and expenses. In addition, there is an allowance varying from 0·15 to two-thirds of a penny per wagon per mile credited to Company *A* for use of their vehicles on Company *C*'s line according to distance and class of vehicle.

Train No. 2 commences on Railway *H*, running for 29 chains over its own line, thence by running powers over 37 chains of Company *K*'s line with fixed tolls of 1 $^3/_5$ *d.* per ton, irrespective of the rates for the merchandise conveyed. Then over 60 miles 22 chains of Company *H*'s own line with a bonus of 3 miles out of Company *L*'s proportion of the throughout rate; then by running powers over Company *L*'s line for 30 miles 53 chains, with a working allowance of 33 $^1/_3$ per cent on the throughout charge. A total distance of 91 miles 61 chains, with three ownerships and four different methods of division of receipts and expenses.

It would puzzle the wit of man to make ton mileage figures show any relation whatever between the rates paid by the public and the receipts of either Companies *A* or *H*, or the other lines over which the traffic passes.

I have a case in mind where running powers are exercised over 25 chains of a railway, the owning company receiving a division as for 1 mile on the throughout distance less 25 per cent; over one million tons per annum being thus conveyed over this short distance.

Where traffic in England is the heaviest, interworkings such as these, or of an allied character, are common, and an immense traffic is moved under such conditions.

If these cases were few and far between it might be reasonable to ignore them in the matter of merchandise and mineral traffic; but such is not the case, and in the great centres of industry they are often found to be the rule and not the exception. A portion of the receipts or the expenses, or both, of one piece of line goes to a company which is not the owner.

One company may be instanced where out of 21 million train miles and 24 million engine miles, 6 million train miles and 8 million engine miles respectively represent the running over other companies' lines.

Joint ownership in halves, in thirds, and even in fifths, have to be dealt with; bonus mileages given or received from 60 chains to 20 miles apply to large traffic exchanges. These bonuses, as a rule, are not allied in any way to the charges levied on the public nor to work performed, but are the result of bargains made when the lines were constructed, and are more or less in amount according to the respective bargaining power possessed by the companies at the date they were made.

The same thing may be said of running-

power arrangements; they vary generally from 20 per cent to 40 per cent. These being mainly parliamentary arrangements, represent, in some instances, less than the working and haulage cost; in others, a great deal more than the cost to which the running company is put. The same remark applies to fixed tolls to the company exercising running powers.

The publication of ton mileage figures upon such a basis as this could be of no practical use either for the purpose of comparison between company and company, or as a guide to the charge per ton per mile paid by the trader, or the cost per ton per mile of haulage. The only people who could make use of such figures would be those who are ever ready to beat the "railway dog" with any stick that will come to their hand.

Apart from the fundamental objection to the publication of figures having a basis of untruth, English railwaymen view with disfavour the taking of an average as regards charge and cost of commodities bearing little or no relation the one to the other. Instances might be multiplied almost indefinitely, but one will suffice:

A twelve-ton truck will convey 12 tons of one particular class of merchandise, whilst other common merchandise of great bulk requires twelve trucks to convey the same tonnage. Thus 12 tons in the one case is upon a vehicle with four wheels wearing out the permanent way; in the other, forty-eight wheels are wearing out the same permanent way. Further, the non-paying weight hauled in one case would be about 6 tons and in the other 72 tons, although the revenue tonnage in both cases is identical and ton mileage statistics treat them as of the same value.

Out of this hotch-potch of receipts and expenses divisible between companies without regard to rate charged or work performed, and of units that refuse to unify, English companies are asked to compile ton mileage statistics. Is it to be wondered at that we object and assert that the cost of such a compilation would be sheer waste of hard-earned money?

It is curious that side by side with the extreme advocacy of ton mileage figures in England the professors of railway administration in America — where probably more attention has been paid to statistics than in any other part of the world — are minimising rather than seeking to give enhanced value to ton mileage figures. Thus, Professor Dewsnup, of the University of Illinois, in a recent article on the subject, says:

> There are some happily-dispositioned writers and regulative bodies who see all these difficulties vanishing into thin air when resort is had to some magical pro-rating basis as train mileage or gross ton mileage on the like. These engineers of philosophy are so much in advance of many of us poor mortals that they have no trouble in determining the roadway maintenance expense due to a 50-miles-an-hour 500-ton through express passenger train as compared with that due to a 12-mile-an-hour 2,500 ton freight train, stopping, may be, at almost every siding. Their attitude is picturesque, but unconvincing.

And:

> An arithmetical average is obtained, it is true, but one of treacherous utility, unless environed by a galaxy of interpreting, modifying and saving clauses, only to be used by the initiated, and even then with the greatest circumspection.

And again he says :

> Yet even ton-mileage is unsatisfactory; its general nature necessarily deprives it of efficiency as a measure where conditions are different, as is commonly the case.

And finally, in emphasising the limitation to be attached to statistics as used in America, he says :

> Neither railway officials nor writers employing such statistics have always exercised good judgment in this respect. Too frequently may they be found resorting to reasoning which suggests, as a well known statistician remarked some years age " a man trying to lift himself over a fence by his boot straps."

Turning now to the question of ton mileage as an aid to management and the manipulation of traffic, I believe that there is little, if any, difference, except in name, between the methods employed on the English railways and those of the United States. In the latter country I believe I am correct in saying that for the purposes of movement of traffic, cars are averaged at " per ton," and the gross tonnage of such cars is given as the measure of the engine load for each particular section of line. In England the method usually adopted is to deal with the wagon according to its class — *i. e.*, weight and bulk capacity — either full or empty, as the measure of engine load. Whilst loading is dealt with in America under the name of " tons," in England it is dealt with under the name of " wagons," the average gross tonnage of which is known. The methods, as I have said, are almost identical, the names alone varying.

The mass of information which is at the disposal of English railway managers in the shape of statistics — weekly, monthly or half-yearly — is much on the lines of the information, although in a different form, enumerated by Sir Thomas Rees Price as common in the English colonies.

The English railway managers shy at average as much as possible, and endeavour to get correct facts in the smallest possible compass. They consider that by their methods they get to know more of the actual conditions than by worshipping the god of averages alone.

I have been asked to state that all the representatives of the English railways who are present at this Congress — with one exception — are quite in accord with the remarks made by Sir Charles Owens and with the conclusions which I have just submitted to you. They are convinced in the light of their experience, and having regard to their investigations and the attempts which they have made to adopt ton-mileage, that this system cannot be applied in England

It is to be regretted that there is no report before the Congress of statistics employed by the various English administrations for the sole purpose of internal knowledge and use, as distinguished from the published accounts.

Mr. Hale, American Railway Association. — I trust that the Congress will adopt the conclusions given in the report of Mr. County. They are entirely in line with the facts as stated, and are expressed in such general terms that they can hardly be objected to.

Mr. County shows clearly the advantages of statistics so framed that railroad officers

can use them as a guide in superintending the work of their subordinates, a most important function of statistics.

I had not intended to enter the discussion of ton-mile statistics, but in view of certain statements which have been made I feel obliged to call attention to a point or two.

The gentlemen who object to ton-mile statistics feel that their use will be unfavourable to the proper handling of a varied and high class freight service such as is performed in Great Britain. I can only say that when I had charge of the fast freight service of the Pennsylvania Railroad I found ton mileage statistics of the greatest use. It is not necessary always to use ton mileage figures based upon the average of all freights; they can be worked out for any and every kind of freight, and such figures are frequently of advantage.

Mr. Sam Fay has quoted to us the opinions of Professor Dewsnup, but I hardly think that Professor Dewsnup would claim that he is an exponent of American opinion. He is an Englishman, and has only lived in America a few years. Mr. Dewsnup and I are very good friends. I have, at his invitation, spoken to his classes, but there are certain lines in which he does not represent the views of the practical American railroad man.

There are many cases in America where the trains of one company move over the lines of others in the manner cited by Mr. Fay. For instance, every train of the Baltimore & Ohio Railroad which leaves Chicago runs over the track of four companies. We know, however, the tonnage and the mileage, so there is no difficulty in obtaining ton mileage comparisons with receipts or expenditures.

I must confess that I cannot understand how a railroad manager without ton mileage figures can form a just idea of the performance of his property.

Meeting held 8 July 1910 (morning).

MR. COLSON, PRESIDENT, IN THE CHAIR.

Mr. Jacomb-Hood, London & South Western Railway. — I should like to say that the use made by Mr. Acworth of an illustration I employed when lecturing on the expenditure of railway maintenance, to railway students of the London School of Economics is entirely misleading.

I did, at that time, point out to the students the necessity for the most careful analysis and classification of items of expenditure, if economy was to be secured and explained that, for internal purposes, they must *not* be content with the few comprehensive items, called for by the statutory returns of English railway companies.

I did state that, for practical purposes, I regard these few items as quite insufficient, and that it would be an advantage, and would tend to economy if the careful statistics already compiled

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by most of the responsible engineers of railways in England were, generally, adopted.

I *repudiate* the suggestion that any English railway engineer does use the five items of expenditure in the statutory form of accounts, as items to which expenditure is charged promiscuously.

As representing a body of men who annually spend large sums of money upon railway maintenance I express the view, in which I believe most railway engineers will agree, that any reasonable means of putting expenditure to the test of analysis and comparison are justifiable, and will tend to secure economy and I state confidently that, for internal purposes, such tests and analyses are already the general practice.

Mr. Patterson, — Far be it from me to contradict a single word of Sir Charles Owens' kind comments on Mr. County's report. On the contrary, as Mr. County's representative, and on my own account, permit me to offer our sincerest thanks for Sir Charles' kindly and eloquent words.

It is, however, only fair to Mr. County to say that he speaks of ton mileage statistics as a *fait accompli* — not as a statistic on trial. As a *fait accompli* he sounds a note of warning as to using them wrongly, or as "the *only* flower in the garden," to quote Sir Charles' simile; but his warning is as to the *use* of the statistic, and not in opposition to its existence, for he believes in it cordially, I am sure.

The value of a statistic is in its *proper* use. It is, perhaps, a bit dull and dry, but nevertheless it may be useful to show *how* statistics of ton mileage may be used and yet avoid the dangers outlined by Mr. County and so ably and kindly summarised by Sir Charles Owens; and so I ask your indulgence, Mr. President and gentlemen, to present on behalf of the Pennsylvania Railroad Company a special case not entirely dissimilar from many cases on other American railways.

The case which we respectfully present is a comparison between ton mileage costs on the New York and Philadelphia Divisions of the Pennsylvania Railroad. These two divisions are very dissimilar. The Philadelphia Division has a predominance of mineral traffic, with long haul. The New York Division has a predominance of merchandise traffic and short hauls. The Philadelphia Division includes the city of Philadelphia, with a terminal delivery traffic conducted by rail deliveries. The New York Division comprises Manhattan Island, with a terminal traffic conducted by water deliveries. The ton mileage statistics showed the *fact* that the costs per ton per mile on the Philadelphia Division were about 3 mills, and on the New York Division 8 mills.

These facts developed a tendency to jump at the conclusion that the trouble was with water deliveries versus rail. But we again used ton mile statistics in much greater detail, separating train costs, lighterage costs, shunting costs and station costs, and found that while all had a bearing, the *station* costs were the principal cause of the grave difference between the two divisions.

Mr. President and gentlemen, I claim that this very instance which I have given you shows that ton mileage properly used gave us a knowledge as to station costs which we would not otherwise have had.

I couple this claim with the most cordial acceptance of Sir Charles Owens and Mr. County's warning that, generally speaking, as well as in the particular instance given, we might (perhaps we often have) used this statistic wrongly — every statistic may be used wrongly as well as rightly. For example, every statistic may be used alone, disjointed from all others, and so deceive. Ton mileage statistics are no exception to this general rule, but *rightly* used I claim they are the brightest rose in the statistical garden, to re-quote Sir Charles Owens' simile.

I ask the indulgence of our learned and kindly French friends to borrow from their lovely and logical language what I may call in my " fierce " American accent " *L'Envoi* " :

1° The comparison of these divisions on the Pennsylvania Railroad showed us our station practice was deficient;

2° It started us thinking about other country' station practice;

3° The Americans are not a modest people yet in this matter of station practice. These comparisons of ton mileage costs have made us more humble, and so we claim for them a virtue in the highest sense;

4° The result of our study of these comparisons of ton mileage costs has turned our minds toward station practice abroad, and especially in London;

5° Our observation of the conditions in London leads us to the impression that the English railway officers are away ahead of us in their station management and we can kneel at their feet as learners.

Mr. President and gentlemen, if I or any of my American confreres here are sent to dear old England, the country of our forebears, to study station practice, and kneel before Sir Charles Owens as learners, may I not hope that Sir Charles will give ton mile statistics the credit for our humble attitude.

Mr. Appleyard. — A desire has been expressed for information about the division of the expenses for passengers and for goods; I very willingly hold myself at the disposition of the members of the section in order to give them all the details I have.

As regards ton-mile statistics, I think that general information is very desirable, but that it is very difficult to obtain as regards details.

In the case of the lines in South Africa and in the other colonies, the comparison of the statistical results with the returns of the other countries and especially with those of the American railways has been very useful and has made it possible to introduce great improvements in the working.

Returns should be drawn up for periods of a certain length, for instance ten or fifteen years.

The returns of the expenses are of particular importance as regards the organization of the line, the staff and especially the amortization which differs widely in the different countries.

Mr. von Strigl, Austrian State Railway. (In German.) — Mr. Chairman and gentlemen, I should like to say a few words about a question which has already been mentioned several times during this discussion and this has also been made the subject of some proposed conclusions.

This is the possibility of comparing the statistics of railways with each other and,

the case arising, of drawing up an international standard for those statistics. I will begin by remarking that Austria has always devoted special attention to the development of railway statistics and that every year a very complete publication appears, which contains, under 1,326 headings, not only the most important results of the operation of the railways, but also a certain number of other useful particulars. Moreover, these statistics deal, on absolutely identical principles, with both State railways and privately-owned railways; not only with main and local lines, but also with minor lines, that is to say, with lines of the most secondary character; finally, also with the industrial connections.

Now, as has already been stated here several times, it is certainly of very great importance that it should be possible to compare this statistical information with that of other countries. Unfortunately, no exact comparison is possible, even on the smallest scale. Similarly the railway statistics of other countries are not as a rule comparable among themselves. It has to be noted that the Austrian government has always as far as possible assisted the efforts made, now for many years, to establish international railway statistics. In this connection I should like to mention an attempt to establish international railway statistics, a description of which was published twenty-five years ago, drawn up and published by Mr. von Brachelli, aulic councillor, of the Austrian ministry of commerce, which then dealt with railway matters.

The question which now arises is whether the present state of affairs, the impossibility of comparing the statistics of different countries with each other, can be modified in the more or less near future. Taking my experience into consideration, I answer this question frankly in the negative. Independently of the diversity of the conditions which affect the statistics in the different countries generally, the classification varies widely, as a rule, in the different countries, as regards the subjects placed under similar headings. Now in all countries the statistical classification, in particular, is closely connected, as regards financial results, with the book-keeping systems adopted in the different countries, and from the moment that, as we have been informed, differences exist inside one and the same country, which cannot be at once made to disappear, it is evident that those differences must be still greater from country to country and that it is hardly possible to eliminate them. In fact every railway will no doubt refuse to rearrange, in a generally radical manner, simply in order to make statistics comparable, the system of book-keeping it is accustomed to, which is specially suited to its conditions and which above all is intended to meet other requirements than those of statistics proper.

The difficulty in the way of any measure of this character is clearly shown by the statistics of the German *Verein*, about which one of the previous speakers expressed the opinion that they might serve as a basis for international railway statistics. However, the determination of the figures for these statistics of the *Verein*, which only includes the German, Austrian, Hungarian, Rumanian and Dutch railways, causes great trouble to many of the railway administrations, although

these statistics include much fewer details than the official railway statistics of other countries; so that very many statistical data have to be included in a given form. Now it is evident that any extension of these statistics, even if the data to be published are reduced in number, should be very ample, if the international railway statistics are to have any value; I mean that from the point of view of the countries included, they should present but few or no appreciable gaps, and that is not possible. I may remark that the difficulties mentioned just now in the way of drawing up the *Verein* statistics have now already led to the adoption of preliminary measures, in the direction of reducing the extent of those statistics materially, probably from 1910 onwards, so that they will be but one quarter of what they were previously.

Now although the reasons which I have just very briefly set forth, make me hold the definite opinion that the conditions necessary for the establishment of international railway statistics at present do not exist, nor will come into existence in the near future, I will, however, not omit to present a proposition which is intended to reconcile the opposing points of view. In fact, although it is probable that the Congress will arrive at the conclusion that the bases necessary for the establishment of international railway statistics at present do not exist and cannot be created, yet it could express the hope that the Permanent Commission should investigate the question whether it would not be advisable to collate and publish certain principal statistical data concerning the railways of the countries represented in the Congress. This information should, in a summary form, include: the length constructed and operated, the capital expended, the stock and mileage of the vehicles, the number of passengers carried, the tonnage of goods carried, the total receipts, the total expenses and, lastly, the final financial results.

It will perhaps be possible later on to supplement, progressively, with other information, these short returns which can be established on a uniform basis and possess a certain value, particularly if they are published as quickly as possible. In any case, one would then start with a basis for international railway statistics, which it is at present unfortunately impossible to draw up, and their compilation will probably be left to a future generation.

The President. (In French.) — Gentlemen, I think it useful to remind you that we have no English shorthand writer present, because the official language of the Congress is French, and speeches should in principle be delivered in French or in the language of the country in which the Congress meets. The notes taken by the secretaries hence only enable us to give a short summary of the speeches made in English. I consequently request the speakers, using languages other than French or German, who desire that their speeches should be reported in full in the *Proceedings* which are published later on, kindly to give copies of their speeches to the bureau.

Mr. Voorhees, Philadelphia & Reading Railway. — A uniform preparation of statistical reports properly prepared and used year by year is of great value to a railway.

The comparison of the results reported as between different railways is of little value and is apt to be misleading to the investor, the law maker and the public in general, unless studies by those intimately acquainted with the characteristics and traffic of the railways whose reports may be compared.

The study of the statistical reports of any given railway will not result in obtaining the actual cost of any operation.

The net returns of the working of the railway as a whole may be obtained.

To determine the actual cost of any element is an impossibility no matter how precise may be the instructions as to the classification of expenses, and however much care may be used in carrying them into execution.

Mr. H. C. Allen, Buenos Ayres Great Southern Railway. — In the evidence which I gave before the Committee referred to by Mr. Acworth I said that although my company had kept ton-mileage and passenger ton-mileage statistics for twenty years, we had found them of practically little or no use, and would discontinue them but for the fact that the information has to be prepared for the Argentine Government annual statistical returns. Twenty years ago, I was, like my friend Mr. Acworth, a statistical enthusiast, or perhaps I should rather say, theorist. Since then the practical application of theory has altered many of my earlier views, and while I think that the present British Board of Trade form of railway accounts leave much to be desired, I agree with my English railway colleagues that their efficiency or inefficiency does not depend on the inclusion or expulsion of ton-mileage statistics. There are, of course, some lines where, owing to the regularity of the classification of the freight and the tare and capacity of the wagons, ton-mileage statistics may be a reliable factor for testing either the earnings or expenditure, but where these vary, as is especially the case in England and is now rapidly becoming the case in Argentina, the ton-mileage averages become misleading and consequently dangerous statistics, except in the hands of statistic experts, well versed in local ruling conditions and thereby able to make their own deductions before arriving at a definite decision. Mr. Sam Fay has shown by quoting examples how difficult, if not impossible, it would be for English railways to get out ton-mile statistics, and even apart from the difficulties of the task there is the question of the cost and the absorption of the energies of the staff in filling up endless forms for the audit or accountant's department, instead of devoting their time and attention to promoting the efficiency of the train services. Some years ago my company kept statistics of the percentage of freight to capacity hauled, but we put an end to that as it was found the staff were devoting all their energy to securing effective statistical results rather than to the earning of dividends or satisfying public requirements. Statistics may be overdone, and at one time they certainly were overdone on the Buenos Ayres Great Southern Railway. I am satisfied that had the Argentine railways never gone in for ton-mileage they would not do so today. Our traffic varies from month to month with the seasons. One month the line is carrying wool, occupying 20 per cent of the wagon

capacity, but earning 54*s.* per ton, while the following month the line would be carrying grain, occupying the full capacity of the wagons, but only earning 6*s.* per ton. With such varying classifications, what possible use can be made of ton-mileage averages? Again, taking the so-called gross ton-mileage which the Argentine Government insisted on, that is merely the total tare of the wagons divided by the axles, and a unit of two axles per wagon was adopted for all statistical progress, and this, multiplied by the total vehicle-miles run plus total ton-mileage, gives the so-called gross ton-mileage. As, however, the railways have in service all classes of wagons, from an 8-ton with 10-ton tare to a 45-ton with 15-ton tare, what reliability can be placed on the average gross ton-mile? Efficiency in operation can only be obtained by every traffic employee intelligently watching and recording every train coming under his notice and reporting promptly where there is any evidence of careless loading or extravagance in hauling power. It was hoped that by carefully recording gross ton-mile statistics it would have been possible to appropriate the cost as between passengers and goods, but after many experiments it was agreed that, although statistics showed it cost $2\,^1/_2$ times as much to carry a passenger ton one mile as a ton of goods, this was disproved by subsequent experience. It is all a case of averages, pleasing, possibly, to the theorist, but useless and misleading to the practical railwayman.

Mr. Plant, Southern Railway, United States. — Recognizing as we do the value of and the substantial benefits to be derived from proper and accurate statistics, the papers read and the discussions on this subject are very interesting to the delegates from the United States.

Competition and an upward tendency in the cost of both labour and materials, with no corresponding increase in the rates charged for transportation, make it necessary for us to watch most carefully operating costs. This supervision can be given only through the medium of proper and reliable statistics drawn to show both the traffic produced and the costs to transport it.

Railway statistics in the United States may be divided into two classes; *i. e.* :

1° Statistics reported by the directors to the shareholders and those required by the State and Federal Governments;

2° Statistics prepared for the managing officer, which are used by him in determining the efficiency of operations and of individual operating officers.

Those referred to in the first class are prepared and reported annually, along fairly uniform lines, and they are general in their character.

Those of the second class are prepared in much greater detail and are reported daily, weekly and monthly along lines best suited to meet the requirements and the physical and traffic conditions of the individual railway.

On many railways, statistics are prepared to show not only the results of the entire line, but also those of each operating division or section, of the individual operating officer, the train, the locomotive, and on some lines the individual engine driver and the fireman.

In discussing this subject I shall, as far as practicable, confine my remarks to

those statistics referred to in the second class which are prepared and used on the lines which I represent.

In the first place, I desire to talk about the method which we use, not only in producing statistics, but in the general audit of our revenues, especially revenues derived from freight traffic.

Way-bills or manifests upon which freights move are forwarded daily by the agents at receiving stations to the audit office. Upon receipt in the audit office all data necessary to the audit and for statistical purposes are transferred by means of punch marks or holes to a card. Thus we have a card representing each way-bill and carrying all information required. After preparing the cards in the manner described — which is done at the rate of from 250 to 300 cards per clerk per hour — the remainder of the work — both the audit and the statistical work — is done mechanically through the medium of electrical sorting and tabulating machines.

The element of error is reduced to a minimum and the errors are confined to the punching of the cards. The average record is less than two errors per one thousand cards. The errors, however, are detected and reflected by the tabulator in the audit, so when we come to the preparation of statistics the cards are practically free from errors.

To determine the volume of any particular class of traffic moved between a pair of stations, all the cards from and to those stations are placed in the sorter, which is set for the particular class desired. Electricity is applied, and the cards for the class of traffic desired are separated from those of other classes at the rate of, say, sixty per minute. The cards are then placed in the tabulator, and the tonnage and the revenue are determined electrically and with perfect accuracy.

Practically all freight revenue accounting and the statistical data, including the division of revenue, tons and ton-miles between states, operating divisions and individual lines, and also between State and Interstate traffic, are produced through the medium of the tabulator. Classified tonnage statements from individual stations showing revenue, tons and ton-miles are also produced with the tabulators.

Thus accounting costs, as well as the time requisite to the production, are reduced to a minimum.

There are three important elements in operations in which statistics are not only useful, but very essential to economical operations.

They are :

1° The solicitation and equalization of traffic;

2° Transportation costs to receive, transport and discharge traffic;

3° Locomotive and train load.

It is very necessary for the chief traffic officer to know the results accomplished by his field officers, particularly with respect to the volume of competitive traffic secured. It is also of great importance to him to know whether or not his line is receiving the longest possible haul on traffic originating on his line destined to points on other lines, and on traffic moving in the reverse direction. It is likewise important for him to know the volume of competitive traffic received from and delivered to each connecting line at individual junction points. The equalization of

tonnage in both directions over an individual line or section, to the end that empty one-way hauls may be avoided, is a very important matter. All this information can and should be shown by statistics.

Numerous units are produced for gauging transportation costs, prominent among which are: locomotive, train and car miles shown separately as between passenger, freight and mixed, whether light, helping, loaded or empty, and the direction in which moved; individual gross transportation costs and costs per locomotive mile for enginemen, fuel, lubrication and other locomotive expenses; costs per train-mile for trainmen and for other train expenses, and for yardmen or shunting service; pounds of coal consumed per locomotive and per ton-mile and station service per one dollar of revenue earned. The locomotive and train load is a most important factor to be reckoned with.

Operating costs may be reduced to a minimum and the economical results thus accomplished are destroyed unless the maximum freight-train load is secured at the start and maintained throughout the journey of the train. The hauling capacity of locomotives is known. Each locomotive is rated and efforts are made to load them to their maximum capacity. The tonnage of each car is determined from the weight of the traffic shown on the way-bills or manifests which accompany it. To this weight is added the tare weight of the car, and in this manner the actual gross weight of the car with its load is determined, and the weight thus produced is used as a base for loading locomotives.

Through this medium each division superintendent is advised daily of the train tonnage on his division. The general manager is advised of such results, together with the results showing ton-miles per train and per locomotive and costs for enginemen, fuel, trainmen and other locomotive and train costs per ton-mile, through the medium of statistics prepared in the general office.

Much has been written about the railway statistics of the United States, and I regret to say that possibly some of our English and Continental friends have been confused by some of the articles sent abroad. Some writers tell us it is possible to determine the total operating costs to move one ton of freight one mile or to transport a passenger one mile. We can approximate such costs, but we cannot and I doubt whether we shall ever be able to determine them accurately. But few of the American railway accounting officers attempt to make the separation, and when made, the results are used for comparative purposes only.

About fifty to sixty per cent of total operating costs can be accurately assigned to the two classes of service; the remaining costs must be arbitrarily assigned.

Prior to 1 July 1907, there was a diversity of accounting methods and practices on American railways. While generally speaking the principles were the same, the methods were not, and it was difficult to satisfactorily compare operating results, one line with another.

Simultaneously with the passage of the Act in 1906 vesting in the Interstate Commerce Commission the power to prescribe the accounts to be kept by railways subject to the Act, a committee consisting of

twenty-five chief accounting officers of railways in the United States was appointed by the Association of American railway accounting officers for the purpose of aiding the commission, through its representatives, in unifying and modernizing our railway accounting methods.

This work has been under way for nearly four years, and is about completed.

We now have uniformity in classifications of revenue, operating expenses, locomotive, train and car mileage, additions and betterments, and construction expenditures and also in the form of the general balance sheet.

Just emerging as we are from a four years' siege of accounting changes and reformations, the railways of the United States would, I daresay, hesitate to approve the suggestion made by my German friend for a form of international statistics. The thought is a pretty one, an interesting one to contemplate, but we of America feel that we should sit still for a while and catch our breath.

We should be glad to know what our Continental neighbours are doing, and should be pleased to show them what we have in the way of statistics; but, as I view it, there are many reasons why an international method or plan of statistics would be impracticable.

Statistics, to be of value and to be used effectively, must be available promptly after the performance of the service for which they are prepared. They should be accurate and in my judgment drawn to meet the requirements of the individual line They should deal only with those costs or factors incurred and created directly by the operating officer under review. The introduction of averages, estimates and irrelevant elements, in my judgment, destroys the real value of the statistics.

Mr. Mahl, Union Pacific Railroad. — I thank my English friends for their communications relating to the question of statistics. If the American railways tabulate very minutely all relating to passenger-mileage and to ton-mileage, it is because they wish to have this information as units for the intelligent operation of their lines.

The American companies are transport undertakings which above all try to augment the number of passengers carried and the tonnage of the goods. They also wish to be able to compare accurately what these transports bring in and what they cost, in order, on the one hand, to increase the receipts, and, on the other, to reduce the expenses.

The chief result they aim at is the development of the traffic and they also strive to give the public a good service. The companies also try to equalize as much as possible the traffic between their different lines and do their utmost to have the trains as fully loaded as possible.

The accurate data supplied by the passenger-mile and ton-mile statistics have enormously contributed to the progress of the American railways, which have increased since 1860 from 30,000 miles to 270,000 miles.

In conclusion, I thank my French, English and German colleagues for the information they have kindly supplied.

Mr. Rathgeb, Swiss Federal department of posts and railways. (In German.) — The International Railway Congress, which occupies itself with useful investigations

of all kinds, has also extended its researches to the method of compiling railway researches and statistics. Statistics are certainly an interesting field. This is proved to us by the fact that they have been existing since there have been railways, that they have for a long time been among the agenda of the Congress and that many delegates from all countries and railways have come to take part in the Berne session.

We other Swiss have been looking forward to this session with pleasure. In our small country, much importance is attached to accurate statistical information. Railway statistics are especially complicated, owing to the large number of railway enterprises and of systems of traction. If some day the monorail is added to the latter, the task of the statistician will become even more arduous.

Should the Congress investigate whether it is better to compile statistics at once, or annuals returns? We think that both systems can render excellent services. The practical and experienced official, who wants to keep acquainted with the importance and the progress of the service, will easily find the material for daily, weekly or monthly returns, of the carriage of passengers and goods, the number of trains and the journeys of vehicles. Those are accordingly points which it is superfluous to discuss at length.

The question which seems to us of much greater importance, is that of the annual statistics. We would like to ascertain, at the end of a sufficiently long period, whether there has been any forward or any retrograde movement, and whether there have been any changes in certain services. This information is of interest to the managing officials, as well as to the capitalists and to the higher authorities.

In order to make a complete comparison, we also consider the results of neighbouring enterprises and the railways in other countries. As regards the latter, our interests blend. It is no doubt for that reason also that it was desired to bring before the Congress the subject of uniform statistics and that the Congress has already adopted a resolution stating that it was desirable to unify the book-keeping of receipts and expenses.

The realization of this resolution, which was adopted in 1905 at Washington, would form a first solid foundation for a universal movement in favour of the unification of railway statistics. We have today learnt how the differents unions, for instance the European railways, try to unify their systems of book-keeping. On the other hand, the interesting reports submitted by the reporters show that in America also a common basis is sought for. We have, moreover, learnt, with much pleasure, from South African delegates that the normal principles of statistics have now been unified there and are clearly determined by the different railways. We thus see that there are movements in favour of uniformity, in all the countries, in all parts of the world.

We might also mention that the International Light Railway Union, which is an association of tramways and of narrow-gauge railways, is ahead as compared with main railroads. Years ago already the "light railways" have laid down a standard programme of receipts and expenses, which has been adopted as an obligatory standard by a large number of enterprises of this kind.

The need for comparison is also felt by other administrations, such as those of posts and telegraphs. The central offices organized at Berne publish every year very detailed statistics of the results obtained in the different countries.

We in Switzerland expect happy results to follow this session. We have now for quite a long time been intending to make alterations in our system of book-keeping, which dates back to twenty-five years ago. Electric traction, which has recently come to the front, makes it necessary, from many points of view, to modify the classification. There are lines with mixed traction: steam traction and electric traction. Electric trains are generally of another kind and of another type as compared with those on steam lines. The staff and the rolling stock have had new classes added. It is necessary that the statistics should allow for and deal with those new conditions by a corresponding extension of their scope. We hope to find at this session of the Railway Congress new information and bases utilizable for a future system, universally applicable, of book-keeping and of statistics. Now it seems, in spite of the very comprehensive reports and the long discussions, that the question submitted to the meeting is not yet sufficiently elucidated and that one cannot record any practical agreement as to this question. Differences will exist between one country to another. Under these conditions, it will be difficult for us to come to any decision. We do not know whether we are to uphold the regulations in force on the German railways, or to support the French standards, or whether it would be preferable to adopt the new American classification, or the simpler English system. But perhaps we should do better if we improved our existing methods and try and deduce standards from them.

Gentlemen, the difficulties of unifying statistical bases are well known, and we cannot make them disappear from today or tomorrow. These are caused by the national laws, by the railway regulations, by traditions, by opposition on the part of the directing authorities, and by many other causes. In certain circles there is perhaps also some antipathy or apathy as regards statistics, which hinders the solution of the question. This new auxiliary science often presents itself with a voluminous, proud and exaggerated appearance, and sometimes involves an amount of work and expenditure which is not justified by the result.

In order to arrive at any result, it would in every way be advisable in the first place to establish certain simple and fundamental facts, as has been well said by Mr. von Strigl, delegate of the Austrian State Railway. We must not for the moment enter too much into detail, nor must we examine whether the results of working are to be determined and compared on the basis of the ton-kilometre or train-kilometre or any other unit. It would be advisable, in the first place, to come to an agreement about the fundamental principles, that is to say, about the uniform classification of the working expenses. In order to determine or compare the working expenses either as a whole or in units and services, they must, to begin with, be classified according to the same principles. Consequently, it must not happen that the expenditure on the locomotive staff and on the coal consumed should be placed under one head

by one administration, and under another by another administration.

The possibility of unification seems to exist, because every normal railway, whatever country it may be in, has characteristics in common with the other railways. We find everywhere fixed installations which have to be maintained in good and safe condition, a rolling stock which must be driven and conducted, a service for dispatching transportation, a general administration which directs the whole work and considers matters of finance. It is certain that sooner or later one will come to an agreement as to a common system of statistics for these principal services and that gradually other sets of statistics will receive the same form. But in order to arrive at this unification, we must try to conquer existing obstacles. Many prejudices will have to disappear. There must be a certain spirit of conciliation between the nations. The delegates of the different nations and parts of the world must join hands; an admirable example of this is exhibited by the international postal monument at Berne. In order that the Congress may really arrive at useful results, it is hence necessary that the resolutions passed at the sessions should not be purely negative conclusions or only express simple wishes. This great meeting of railway delegates must not be contented with declaring that there are many difficulties opposing the unification of the bases of book-keeping and of statistics; it must on the contrary make a strong and logical effort to overcome these obstacles.

The President. (In French.) — Three other members have given in their names as wishing to speak, not including Mr. Acworth who no doubt will desire to answer some of the remarks which have been made about his report.

I therefore propose to you to adjourn the meeting and to continue the discussion this afternoon. (*Approval.*)

Meeting held on 8 July 1910 (afternoon).

MR. COLSON, PRESIDENT, IN THE CHAIR.

Mr. Hyde, Great Eastern Railway, Great Britain. — I desire to associate myself with the remarks of Sir Charles Owens and Mr. Fay with which I entirely agree and wish to supplement them with e few particulars.

I think it will be admitted that the only value of statistics lies in their accuracy and that any treatise thereon should possess the same qualification.

It is therefore to be regretted that Mr. Acworth did not obtain the assistance of a practical railwayman before publishing his report in order to avoid the inaccuracies which have crept in.

For instance in discussing the proposed form of accounts as recommended by the committee appointed by the Board of Trade he states (p. 91) (1) that railway

(1) Vide also *Bulletin of the Railway Congress*, number of January, 1910, p. 7.

expenses of locomotives have for the first time been definitely separated from maintenance expenses!

I may remind him that the locomotive running expenses are separated from the maintenance expenses in the present form of accounts and have been so separated for the last forty years.

Page 92 of the report informs us that the present practice of the railway companies is to charge the cost of collection and delivery of all traffic whether by goods train or by passenger train against the goods traffic receipts.

This is inaccurate, as the railway companies properly discriminate between the two heads of expenditure and apportion them accordingly.

I would also call your attention to page 90 wherein in discussing the new form of accounts the following appears :

> The total receipts of all the various branches of the business, railway, steamboats, canals, docks, etc., are brought together, the total net income is established and the proposed appropriation thereof to the payments of interest, to dividend and to reserve funds set out in logical order.

One naturally concludes that this is one of the improvements brought about by the committee, but in point of fact this is merely the continuance of the principle which already exists in the railway accounts *viz.* in the revenue account the net revenue account and the proposed appropriation of the balance.

As regards the question of ton-mile statistics, and passenger-mile statistics, it is obvious that when applied to all railway companies without due allowance for the varying conditions, any comparison must be valueless and not only valueless but dangerous and misleading.

Not only are the circumstances of different countries dissimilar but different railways within the British Isles are subject to different conditions and further there are also differences between the different districts of a single railway company.

On the Great Eastern Railway for example, the greater part of the system runs through an agricultural district sparsely populated and with a light traffic as a result, whereas in that section which lies nearest to London, the traffic is dense, the two sets of conditions being of an entirely opposite nature.

Again in comparing one railway with another, let us take two examples.

Railway *A* is mainly concerned with heavy mineral traffic worked over easy gradients whereas railway *B* has no minerals at all but only a light agricultural traffic and difficult gradients over which to work it.

Again, as regards passenger traffic, railway *A* in a busy manufacturing district has a good "town to town" traffic distributed fairly evenly over the whole day, whereas railway *B* has a traffic very heavy at certain times of the day, and slack at others.

The conditions therefore are out of all comparison and to apply one rule to them all merely results in conclusions which are misleading.

Further Mr. Acworth himself has said that 80 per cent of the heavy traffic varies on different railways.

What is really essential is that the executive officers should be in possession of detailed statistics as regards the movement of the traffic and that these statistics

should be in their hands as soon as the traffic passes.

This is the practice which prevails at the present time and no quantity of ton-mile figures could effectively replace them.

The President. (In French.) — Several members have asked me to request the speakers to be as brief as possible, in the hope of finishing the discussion of this subject today. As we still have to hear the reporter, who wishes to reply to the numerous remarks which have been made, it is advisable not to be too long and to avoid repetitions.

Mr. Aslett, Furness Railway, Great Britain. — I am of opinion that certain alterations should be effected in the British railway statistics. The reform bill will no doubt go through and it will thus be possible to introduce the desired changes in so far as it concerns the question before us, more especially the question of passenger-miles and ton-miles.

The companies endeavour first of all to ascertain whether the transports pay or do not pay. There is a great difference in the transport of heavy goods, coal, coke, iron and steel. The companies receive the particulars as to weight, and when there are special trains, particulars are also supplied concerning the loading of these trains. The British companies can obtain this information without a great deal of expense or difficulty.

I am of opinion that it would be useless to multiply and complete the statistics, considering that this entails a loss of time and that it is better that the officials should be able to give all their time and all their attention to the railway service proper.

As regards the accounts, every month I hand over to my Board a complete extract of the distances covered by the engines, and a statement of the receipts and expenses, and this information enables them to establish the comparison between the results obtained every year with those of the previous years and months.

To conclude, I am of opinion that it is not desirable to overweigh the executive bodies with too many statistical details.

Colonel Bonham Carter, Madras & Southern Mahratta Railway. — I feel that an apology is due from a comparatively unknown man for taking up the time of the conference. My excuse is that in India we have had for nearly sixty years uniform principles of accounting, for nearly forty years uniform accounts and for the same period a mass of published statistics based on every conceivable unit, train-mile, ton-mile passenger mile and gross ton-mile, a part of which will be found reproduced on pages 53 to 56 of Sir Thomas Rees Prices' report (1).

With regard to my personal qualifications I was three and a half years under-secretary for railway traffic and statistics to the government of India and subsequently for seven years the general manager of a system of 1,600 miles.

It appears to me that three of the reports dealing with statistics from the point of view of the Congress hardly distinguish sufficiently between operating accounts, returns, or temporary statistics, and what I would term administrative or permanent statistics and of the objects of these distinct entities.

(1) Vide also *Bulletin of the Railway Congress*, number of December, 1909, pp. 1619 to 1622.

The accounts with the reports based upon them are required to give the shareholders or owners of the railway a statement of its operations as a dividend-earning concern. We should I think all agree that they should be based on sound financial principles and while the reports will give such explanations as are necessary to throw better light upon them, as mentioned by Mr. Hyde, I do not, for reasons which will be mentioned, attach so much value as some to comparisons between different railways while considering that so far as circumstances allow uniformity is desirable.

The operating returns or temporary statistics are and must be rendered daily, weekly or at other short intervals to the officials responsible for working the line, on I should imagine every railway in the world, to enable them to watch the development of traffic and apply remedies to defects in working.

It is the extent to which these operating statistics must be compiled into a more permanent form to give the superior operating officers including general managers the necessary information as to the progress of their business and how far other more permanent administrative statistics must be maintained for comparative purposes over a series of years which is the crux of the whole question. But is not this a question of circumstances? The value of all statistics we are told by our reporters depends on their utility and on the man behind them and on his full knowledge of all the circumstances affecting them.

On a line of such size that the general manager and his assistants can keep in touch with the business and when the administration are close at hand, so that personal explanations are possible, fewer statistics are required than if the general manager has his Board of Directors at a distance as in India or Argentina or manages, as in other countries, so large a system that the president or general manager is bound to base his control to a greater extent on the information furnished to them by statistics.

May I recall to the section a similar discussion on the subject of high capacity wagons at Paris in 1900 and of the resolution recorded upon it? As bearing on the value of statistics as a basis of comparison of the working of different railways, I may mention that the government of India with the aid of the voluminous statistics which are published in that country used for many years to compare the working of each of fourteen railways with its own working for five previous corresponding half years and with the working of two other railways selected as far as possible for their similarity to itself.

It was my duty for three and a half years to make these comparisons. It gradually dawned upon the Government of India that the results obtained were simply the confirmation of the accounts and reports on which the statistics were based and the comparisons were discontinued.

When I became a general manager I found that the system under my control was such that I required an abstract for the different sections of the line of certain operative statistics. I did not find the Government statistics based on passenger and ton miles of any practical use to me. Any information which they contained I

obtained from my operative statistics at a much earlier date and in many cases I found both ton mile and passenger mile statistics misleading.

I will mention one of them.

On a length of line of about 500 miles on which the tonnage hauled was about 700,000 tons and the ton-mileage 100 million ton miles half yearly, the rates in force for coal were something under 0·2 pence per ton mile.

These were low rates, but although the maximum load of an engine was 500 tons of freight and the wagons had to return empty the whole way we were satisfied that they would give us some profit. Owing, however, to sea competition they were not made use of by the public. Suddenly one of our customers decided to carry thin coal by rail instead of by sea and we obtained 40,000 tons or 20 million freight ton miles of this traffic in one half year.

But the effect on the statistics was first to largely increase the proportion of working expenses chargeable against goods traffic which is divided in the proportion of gross ton-mileage, to reduce the average sum received for carrying a ton one mile and to increase the average cost of so doing and reduce the average profit.

This one occurrence thus vitiated the whole of a large group of statistics and showed a loss instead of a profit.

I am desired to add by another Indian general manager present that he shares my views as do many others of the inutility these elaborate statistics prepared for Government purposes. I may say that judged by these statistics (he carries large quantities of jute which loads lightly), his average load is something shocking and his train loads poor compared to those of his neighbour, a grain and coal carrying line. But he rubs along somehow and his line pays 9 to 10 per cent.

Mr. Evelyn Cecil, *vice-president*. — The discussion to which we have just listened would have had a better result if Mr. Acworth had not concluded his remarks in the terms which you have heard. I maintain that it is impossible to say that there are no principles of railway statistics in the United Kingdom.

English companies, like American companies, consider that railway undertakings are a business, and that they should be run like a business.

The object of statistics appears to have been lost sight of. The aim is not to give mere mathematical formulæ; statistics should be used as a sort of pulse to watch the progress of the line.

Mr. County, in his report, put three points which seem to me necessary to impress; *viz.*, the need for obtaining statistical information quickly; the need for clear statistics; and desirability of separating direct from indirect expenses, so as to secure complete results. In short, rapidity, clearness and precision.

Mr. Rathgeb called attention this morning to the great difficulties of unifying statistical results, and Mr. Hyde said that a comparison of them had not, from a general point of view, a great interest for the public. Statistics so complicated are often misleading.

I propose the following resolution :

" Subject to the particular conditions affecting railroad accounting resulting from control of, or financial interest in the railways by the State.

" The Congress finds :

" 1° That statistics, to be of value for operating purposes, should be made available to the operating officers at the earliest practicable date after the performances of the services for a given period;

" 2° To be of the greatest value from an economical operating standpoint, statistics prepared for operating officers should include only such costs as are directly incurred by the officer interested, and all indirect costs should be separated therefrom;

" 3° No one line of statistics should be exclusively relied upon, but statistics reflecting all factors essential to the working of each particular railway, both as to revenue and costs, should be prepared and properly considered;

" 4° That the respective statistics of railway administrations are based on principles suitable to their varying conditions, but that the circumstances and conditions of working necessarely differ in different countries, and that it is practically impossible to arrive at an absolutely uniform system of operating statistics applicable alike to all countries."

The conclusions which I have just read represent the opinion of the British railway companies, and have equally the assent of the American companies.

Mr. Acworth, *reporter*. (In French.) — As a commencement, Mr. President, I should like to apologize in the official language of the Congress for having been responsible for the fact that so much of the time of an International Congress has been occupied by the discussion in English of a question of purely English interest. I seem quite unintentionally to have raised a storm. For two days the storm has raged and after all it is really only a storm in a teacup.

Continuing in English he said :

I will endeavour very briefly to reply to the principal charges that have been made against me. In the first place, I decline to be responsible for what I have not said. I did not say there were no railway statistics in England. Everybody knows that there are, and that the Board of Trade publishes them year by year. What I did say was, " there are no *principles* of statistics". I continue to be of that opinion, and I am confirmed in it by the fact that not one of my critics has so much as attempted to indicate what these principles, if they exist, are.

I repeat that my report is purely personal, and the expression of my individual opinion; but Mr. Evelyn Cecil uses a misleading expression in saying that the Board of Trade has not accepted it. It has not accepted it because it has not been asked to do so. It would be equally true to say that the Board of Trade has not accepted the Ten Commandments.

Sir Charles Owens and other speakers have said that I represent nobody, that I am an amateur. An amateur in the ordinary acceptation of the phrase is a person who devotes himself to a subject for love of the subject itself without hope of personal gain. I do not know whether Sir Charles Owens intended to pay me a compliment, but I certainly accept it as such.

Mr. Jacomb-Hood complains that I have misrepresented him. The words in my paper are as follows :

The chief engineer of one of our great railways a few years ago described these four sub-heads as four paper baskets, which stood by the side of the table of the engineer of each

railway company. It was, he said, a matter of pure accident into which of the four baskets any particular item of expenditure happened to be thrown.

The precise words of Mr. Jacomb-Hood are these :

> A system that provides four vast heads of expenditure, like four big dirty linen baskets, into which all this expenditure as it arrives can be thrown, without much examination or classification, surely stands self-condemned, and calls for the attention of the coming race of railway accounting officers.

I owe Mr. Jacomb-Hood an apology for an inaccurate quotation : I wrote " paper baskets," I ought to have written " dirty linen baskets".

I am accused of being a theorist because I ask for statistics which have no direct bearing on actual operation. But I have never said that statistics by themselves were a remedy. What I have said is that they disclose facts and enable the appropriate remedy to be applied. Let me give a parallel. Nobody supposes that the publication of the comparative mortality in different towns in itself reduces the death rate. But if the figures show that in a given town the mortality from, say, phthisis, is far above the average, they force the health authority of that town to pay attention to the fact, and to set to work to modify the conditions responsible for the unusual death rate.

I have been blamed because I have said nothing as to statistics compiled by the companies but not published, and because I have taken no steps to enquire what these statistics are. My answer is that I regarded published and official statistics as alone coming within the scope of the paper, and there was, therefore, no reason for making any further and private enquiry.

Sir Charles Owens admits the utility of international comparisons, but under present conditions it is impossible to compare England with any other country owing to the gaps in our statistics. Let me give one instance. It is commonly supposed outside England that the English passenger rates are among the highest in the world. The only figure available to outside critics is the ordinary third class rate of 1*d.* per mile. I have often myself had occasion to point out that this ordinary fare is very far from representing the actual sum charged by the English railways for carrying a passenger one mile. I have told foreign critics that in my belief, based on such scanty statistics as are available, the average passenger mile rate in England is hardly more than $^1/_2$ *d.* And I have found, not unnaturally, that foreign railwaymen refuse to accept my conjectural figure as fairly comparable with the official statistics of the average passenger mile rate of other countries.

Mr. Hyde says that comparisons based on ton-mileage are misleading. But comparisons based on tonnage alone are even more misleading. For instance, the Taff Vale Railway and the Midland both carry coal in millions of tons. The Taff Vale has an average haul of say 15 miles; the Midland an average haul which can hardly be less than 50 miles. Surely a comparison between these two companies that ignores the element of distance is at any rate not less but more misleading than would be a comparison which allowed for it. Of course, all statistical comparisons are liable to mislead those who use the

figures unintelligently or unfairly; but when my critics, for example, object to ton-mile comparisons because they lump together ton miles of feathers and ton-miles of coal, they seem to forget that the source of error in this case is in the tons and not in the miles. Now the tons they do give at present, and I have not heard any suggestion that this figure at least should be suppressed.

I am told on the authority of professor Dewsnup that the Americans recognise that ton mile figures are useless, but, apparently, all that the professor has said is that they are not an infallible guide. Nobody that I know of ever said they were, and the fact remains that the American railwaymen, in common with the railwaymen of practically every other country in the world, except England, recognise the utility of ton mile figures as on the whole the best single unit of comparison. Where Englishmen, in default of better information, make comparisons of receipts or expenses per ton, and compare tons per mile of road, Americans compare receipts or expenses per ton mile, and compare ton miles per mile of road.

I am told that ton-mile statistics are impossible in England in consequence of the tangled relations between English companies. But the same conditions, as Mr. Hale and others have shown, exist in other countries and are successfully surmounted. In fact, the minority report of the Board of Trade has laid down precise rules for surmounting them, and no one, as far as I am aware, has ventured to assert, specifically and in detail, that they are either insufficient for their purpose, or incapable of practical application.

The result of our long discussion is, I venture to say, to show that in the opinion of the practical men of the civilised world ton-mile statistics are everywhere practicable and everywhere useful, " England excepted," say the English railwaymen. But at this very moment they are used in practice and found useful in England itself. I am told that thirty years ago, in the infancy of the science of railway management, a general manager of a great English system declared ton-mile statistics to be useless. I reply that, in this present year, the general manager of a great English system, after ten years' experience, finds ton-mile statistics of great practical utility. But enough of a question purely English. I apologise to the section for detaining them so long.

One word in conclusion as to the resolutions proposed for adoption by Mr. Evelyn Cecil. I am perfectly ready to vote for them. For they assert that the statistics of every railway system ought to contain every element both of operating receipts and of operating expenses, and this, as it seems to me, necessarily implies ton miles figures, for I do not think that a railwayman of any nationality will stand up and assert that length of haul is not an element both of the quantum of receipts and of the cost of operation.

The President. (In French.) — I have received from Mr. von Strigl a request for the closure of the discussion. If this proposition is adopted by the meeting, I will read out the proposed resolutions which I have before me and the meeting will then have to decide whether it will at once proceed to the vote or whether it will prefer to wait till the proposed resolutions have been printed.

Mr. Timonoff. (In French.) — I am of opinion that the proposition should be adopted but with the reservation that the speakers who gave in their names before this proposition was brought forward, should still have the right of addressing the meeting. (*Signs of approval.*)

The President. (In French.) — I put Mr. von Strigl's proposed closure, subject to the reservation just mentioned, to the vote.

— The proposition is adopted.

Colonel Haines, United States government. — I desire first to state that I do not speak in the name of the government of the United States, nor am I authorized to commit that government to the resolutions which have been reported to this section. Nevertheless, I appreciate the opportunity afforded me to take part in their discussion.

It is a fundamental principle that statistics should be prepared with a view to the purposes for which they are intended. The immediate purpose in this case is to draw upon experience for information to be applied to future operations. Statistics of this character must necessarily be compiled by each railway administration from its own experience, in connection especially with the operations in the several departments of maintenance of way and structures, of maintenance of rolling stock, of train service and of traffic returns.

In these several departments, different units of comparison are used. As to cost of service, there are employed the train-mile, the locomotive-mile, the car-mile : as to traffic returns, there are applied the ton-mile and the passenger-mile. But these statistical units are not capable of comparison with each other. For this purpose there is required some generally accepted unit which may replace or harmonize these several distinct units. Since they are not interchangeable they require some common denominator to which they may serve as coefficients. This conclusion is even of broader application when statistics are to be applied to a comparison of the operations of separate administrations under differing conditions; conditions also varying from year to year and which, in many respects, are quite unlike when a comparison is to be made between railways operated by steam or by electricity.

To my mind, there is but one unit of comparison which can be applied to railway operations under such varied conditions; and that is, the foot-pound unit exerted at the locomotive draw-bar, as determined by the dynamometer. By such tests, there may be definitely ascertained the tractive power exerted in the performance of any train service; and the cost of that service, whether in freight or passenger traffic, may be as definitely determined. From such statistics a basis can be established which will be available for comparison of any railway operations, however varied may be the conditions and circumstances under which they are performed.

Nor should statistics of this character be confused with statements of earnings and expenses, of assets and liabilities. These are matters of book-keeping which are capable of being stated clearly and accurately; for they are based upon records of monetary transactions which

must necessarily balance. In this respect they are to be distinguished from the records of physical facts, and when statistics are to be applied to the comparison of railway operations, the cost of the service as established by the balance sheets must be correlated with the physical facts represented by statistics on some practical basis. This can only be secured by the adoption of a unit of comparison which is capable of uniform application under any circumstances or conditions.

Another matter to which I would refer is the fallacy of the application of averages to special cases. An average is only the mean of the facts under consideration. It is an abstraction, which is rarely of value for practical purposes, as it can only be utilized with advantage for such purposes in operations conducted under identical conditions. For the same reason, averages should be employed with caution when the results of railway administration are to be judged by statistics. If the reputation of a railway management is to be affected by such comparison, it is but a matter of justice that the statistics used for this purpose should be free of any imputation of defect in their composition or of unsuitability for the purpose for which they are intended. This is the purpose for which averages are utilized in the regulation of railway operations by external authority, and it does not seem to me that the propositions contained in the resolutions, as reported, fulfil these conditions; at least to such an extent as would justify their adoption as an international measure.

Furthermore, the character of the official statistics which should be required from railway administrations by a State government is still the subject of investigation in the United States, and with especial reference to the purpose of comparison between them. If the delegates from the United States could present to this section such statistical formulas as have been suggested by Mr. Acworth they would be pleased to do so, but it is impossible, for the reason that this is with them, at the present time, a desideratum yet to be attained.

In conclusion, I would beg of you not to support the resolutions as reported, and not to compromise yourselves by the recommendation of measures which cannot be realized.

Mr. Brandt, Russian State Railway. (In German.) — Since a statistics office exists in Russia, that is since 1873, statistics have been kept of ton-kilometres or of pood-versts, as used in Russia. The tonnage relating to the different railways must be reduced 47 to 49 per cent because in the total there is a certain number of tons counted several times over owing to transfer from the lines of one company to the lines of another company.

The President. (In French.) — There are no more names down for speaking. Does the section wish the different resolutions proposed to be put to the vote, or does it prefer to wait until the text of these resolutions has been printed in the *daily Journal* of the session?

Some members. — Vote at once.

Other members. — Wait till tomorrow

The President. (In French.) — As there is a difference of opinion, I request the meeting to settle the question by a vote.

I now put to the vote the proposal, that we should at once deal with the conclusions proposed by Messrs. Evelyn Cecil and Fairfax Harrison.

— This proposal is adopted.

The President. (In French.) — I now put to the vote, paragraph by paragraph, the proposed conclusions which are as follows :

" Subject to the particular conditions affecting railroad accounting resulting from control of, or financial interest in, the railways by the State.

" The Congress finds that :

" 1° Statistics, to be of value for operating purposes, should be made available for the operating officers at the earliest practicable date after the performances of the services for a given period."

— Adopted.

" 2° To be of greatest value from an economical operating standpoint, statistics prepared for operating officers should include only such costs as are directly incurred by the officer interested, and all indirect costs should be separated therefrom."

— Adopted.

" 3° No one line of statistics should be exclusively relied upon, but statistics reflecting all factors essential to revenue and costs, should be prepared and properly considered."

— Adopted.

" 4° The respective statistics of railway administrations are based on principles suitable to their varying conditions, but the circumstances and conditions of working necessarily differ in different countries, and it is practically impossible to arrive at an absolutely uniform system of operating statistics applicable alike to all countries."

— Adopted.

The President. (In French.) — Mr. Appleyard proposes an additional paragraph which runs as follows :

" The statistical returns of railways would be of much greater value if they were based on a uniform system, on the locomotive-kilometre, the train-kilometre or other unit. In compiling these statistics, it is advisable that there should be uniformity from the point of view of expenses, of amortization and of renewals, in the capital accounts."

Mr. Bloch. (In French.) — Paragraph 4 of the conclusions we have just adopted concludes as follows :

" It is practically impossible to arrive at an absolutely uniform system of operating statistics applicable alike to all countries."

Now the proposed wish expresses the contrary.

Mr. Acworth, *reporter.* — It is not accurate, as Mr. Bloch has stated, that Mr. Appleyard's wish is in contradiction with the conclusions adopted by the section. Clause 4 merely states that it is practically impossible to arrive at a uniform system for all statistics, while Mr. Appleyard states that it would be useful to unify certain well-defined groups. I think that there can be no

reasonable objection to Mr. Appleyard's amendment, seeing that it is certainly desirable, within the limits realizable in practice, to obtain some uniformity as regards some chief points.

The President. — Perhaps Mr. Appleyard will not insist that his amendment should be put to the vote if I in the first place brought before the meeting some other conclusions proposed by Messrs. Timonoff and von Strigl; it seems to me that his amendment is rendered to some extent useless by the other conclusions, which are in the direction of asking, the one the Permanent Commission of the Congress, the other the Central Office at Berne, to act in a certain way as a centralized bureau for collecting uniform statistical information about the railways of the different countries.

The first runs as follows :

" It is desirable that the initiative already taken by the Swiss Federal government in calling a special international conference with a view to a unification of railway statistics should result, in as short a period as possible, in the establishing of railway statistics making it possible easily to compare at least the principal elements of the working of the iron roads in the different countries."

The second runs as follows :

" Considering that the data making it possible to establish international statistics are lacking and cannot become available for a long time to come, the Congress nevertheless considers it desirable that the Permanent Commission should investigate whether it would not be advisable and whether it would not be possible to collect and publish certain important, but summary statistical data about the State railways belonging to the Congress.

" These statistics should include, in particular, the actual length, the length of lines in operation, the capital outlay, the quantity of rolling stock, the mileage of that rolling stock, the number of the passengers, the tonnage of goods carried, the total receipts and expenses and, finally, the definite financial results obtained by the companies."

Mr. von Strigl. (In German.) — I will content myself with the statement that the two conclusions can be adopted without disadvantage, for there is no contradiction between them. As far as I am concerned, at least, I will vote without hesitation both for Mr. Timonoff's proposal and for my own. As regards mine, it is a question of preparing as soon as possible some information essential for international railways statistics. That result can, in my opinion, be obtained in a comparatively short time.

As regards, on the other hand, the proposition to establish a uniform basis for real international railway statistics, I think that we are unanimous in thinking that long years will pass before any tangible result can be obtained and if in the meantime the organization, which in my opinion, and according to the conclusions already voted, seems to be the best prepared, immediately starts on the work and carries out the programme which is rapidly realizable, I think that this does not in the least prevent that the organization mentioned by Mr. Timonoff should devote itself to the arduous task, which

certainly will take long years, which consists in comparing the statistics with each other and establishing international railway statistics.

Mr. Timonoff. (In French.) — I share Mr. von Strigl's opinion. I shall vote for his proposal as well as for mine, because the two proposals supplement each other.

The Swiss government has already taken the initiative and called an international conference; we can but applaud this. On the other hand, it is said that the Permanent Commission of the International Railway Congress could work in the same direction. I equally applaud that proposition, and I think it advisable that both should be adopted.

Mr. Riché, French Eastern Railway. (In French.) — According to Mr. Timonoff's last statements, it seems that his proposal is modified, and that he recommends the adoption of both proposals. There might be serious disadvantages in entrusting to two different bodies the work of elaborating a statistical programme and of laying down the principles.

It might happen that the conclusions of the two bodies differed, and this would retard the solution of the question.

If quick progress is to be made, a single body must be entrusted with the investigation of the question and not two bodies, which while working along parallel lines, might arrive at contradictory results.

Mr. Timonoff. (In French.) — I have not proposed that the work should be entrusted to any permanent body; I have drawn the attention of the Congress to the fact that the Federal government had already proposed the calling of a conference.

All the powers invited have answered in the affirmative; there is only one country, France, which has not yet given its assent.

We wish for a quick solution; there is the preliminary work which has been done and which has taken about three years. I think that the Congress should take this opportunity to encourage the Federal government in its enterprise; but, on the other hand, I see no reason why the Permanent Commission of the Congress should not thoroughly investigate the question which is a very important one and will take much time.

Mr. von Strigl. (In German.) — I would remark that the fear that there might be differences between the results of the work of the two bodies has no justification. Apart from the case, which I have not considered, that Mr. Timonoff's proposal would give results in the more or less near future, it must be remembered that my proposal is that statistical data should be collected and published, while the other aims at the establishment of a scheme of statistics; and when this has been done, there will of course be a comparison of the results obtained in both cases; and after that the work will be entrusted either to Berne or to Brussels.

The objection has been raised that one State has not yet notified its adhesion to the proposition, and I ask you to take due note of this. Austria has notified its adhesion to this measure only under condition that it will be accepted at least by all the States who have signed the International convention for the carriage of goods on railways. I think that Germany has made the same reservation. Thus up

till now the different States are not even unanimous You will, hence, note that this question of form is not yet solved. If we adopt only Mr. Timonoff's proposal, the realization of my project, which is more modest, relating to international statistics, is thereby put off for many years. Now I do not at all see why one of the two organizations would not be able to collect information quickly and work in a way practically, while the other would make investigations and work at the theory; nor do I see why there should be any conflict.

Mr. Fairfax Harrison, *vice-president*. — While I do not question the advantages of any intelligent statistical enquiry, the propositions of Messrs. Timonoff and von Strigl are, I submit, unnecessary at this time, because their objects would seem to be accomplished either through the discussion in the international conference which we have been advised the Swiss government proposes to convene on the subject of railway statistics, or because it is probable that a further study of the question can be counted upon at the next session of this Congress, by reason of the interest shown in the present debate.

The American railways have only recently entirely readjusted their system of accounts to comply with the requirements of the Interstate Commerce Commission under the provisions of a recent law. So far as they are concerned it would, therefore, be legally impossible for them to give adherence to any modifications in their present system which might be recommended in an international interest, and in any event they would deprecate the disturbance of an understanding which, with much compromise of opinion, they have established with their government, through an attempt to effect a uniform system of statistical accounting applicable to all the countries of the world, a consummation which, in any event, it is recognized is practically impossible.

The President. (In French.) — I think that the discussion may be closed. I put Mr. Timonoff's proposal to the vote; you know how it is worded.

— This proposal is not adopted.

The President. (In French.) — I put Mr. von Strigl's proposal to the vote; it has also been read out.

— This proposal is not adopted.

Mr. Appleyard. — I withdraw my proposal.

The President. (In French.) — As Mr. Appleyard has withdrawn his proposal, we still have left the last proposal of Mr. Bloch, asking that the agenda for a future session of the Congress should include the study of the internal statistics which companies keep-for their own proper use, so that the experience of everybody might be turned to profit.

Does anybody second this proposition? (*Silence.*)

As nobody seconds this proposition, it is not put to the vote.

DISCUSSION AT THE GENERAL MEETING

Meeting held on 14 July 1910 (afternoon).

MR. P. WEISSENBACH, PRESIDENT, IN THE CHAIR.

GENERAL SECRETARY : MR. L. WEISSENBRUCH.

FIRST ASSISTANT GENERAL SECRETARY : MR. MÜRSET.

SECOND ASSISTANT GENERAL SECRETARY : DR. A. BONZON.

Mr. Bloch, *principal secretary of the 4th section*, read the

Report of the 4th section.

(See *Journal de la huitième session*, No. 9, p. 3.)

" Mr. ACWORTH (*reporter for Great Britain*) criticized the want of principle in the English statistics and of logic in the way in which they were drawn up. He regretted above all the absence of any indication of the passenger and goods mileage; the numbers of passengers and of tons consigned were alone given. A committee had been recently appointed to lay down the form of statistical returns; but there had been no majority in favour of specifying mileage returns.

" Sir Thomas Rees PRICE (*reporter for the British colonies*) urged the utility of statistics based on a system which would enable different railways to be compared, and emphasized the distinction to be drawn between the definite statistics intended for publication and the provisional statistics intended day by day to inform the head of the different departments how matters were progressing.

" Mr. COUNTY (*reporter for America*) set forth that a new law had given the Interstate Commerce Commission of the United States the power of fixing the form of the statistics and that this had come to an agreement with the railways on the subject. He drew attention to the necessity of having the statistics drawn up by men perfectly acquainted with the services concerned. Finally, while he desired that practice should be uniform, he drew attention to the danger of rules which would hamper proper financial management, by compelling all improvements to be charged to capital account.

" Mr. BARRIOL, who had been appointed reporter for the other countries at a late

date to replace the reporter who had died, limited himself to indicating the logical principles on which statistics should be based.

" Messrs. Frolof (*Moscow-Vindau-Rybinsk Railway*), Timonoff (*Russian government*), von Zluhan (*Wurtemberg State Railway*), von Strigl (*Austrian State Railway*), Rathgeb (*Swiss government*), and Brandt (*Russian State Railway*) urged the great usesfulness of statistics which would make comparison between different countries possible. In order to obtain them, Mr. Timonoff proposed that the steps taken by the Swiss government to summon a conference in order to establish an international agreement should be supported, and Mr. von Strigl proposed that the Permanent Commission of the Congress should be instructed to institute international statistics, utilizing the parts common to the internal statistics of the different countries.

" The discussion on the usefulness of establishing passenger-mile and ton-mile statistics was very animated. Sir Charles Owens (*London & South Western Railway*), Messrs. Sam Fay (*Great Central Railway*), Evelyn Cecil (*London & South Western Railway*), Jacomb-Hood (*London & South Western Railway*) and Alfred Aslett (*Furness Railway*), in the name of the English railways, as well as Mr. Henry C. Allen (*Buenos Ayres Great Southern Railway*) and Colonel Bonham Carter (*Madras & Southern Mahratta Railway*) disputed the possibility of compiling such statistics in a proper manner, at least in England, owing to the way the different railways were mixed up, and that of drawing any useful information from them, owing to the diversity of all the factors which went to make the average. Messrs. Hale (*American Railway Association*), Patterson (*Pennsylvania Railroad*), Voorhees (*Philadelphia & Reading Railway*), Plant (*Southern Railway, United States*), Mahl (*Union Pacific Railroad*), in the name of the American railways, and Colonel Haines (*United States government*) and Mr. Appleyard (*Central South African Railway*) emphasized the benefits gained from such statistics in comparing different railways together. Mr. Acworth (*reporter*) laid stress on the disadvantage that the English railways were the only ones who did not draw up such statistics.

" The section decided on the following conclusions :

DRAFT CONCLUSIONS.

" Subject to the particular conditions affecting railroad accounting resulting from control of, or financial interest in, the railways by the State.

" The Congress finds that :

" 1° Statistics, to be of value for operating purposes, should be made available for the operating officers at the earliest practicable date after the performances of the services for a given period.

" 2° To be of the greatest value from an economical operating standpoint, statistics prepared for operating officers should include only such costs as are directly incurred by the officer interested, and all indirect costs should be separated therefrom.

" 3° No one line of statistics should be exclusively relied upon, but statistics reflecting all factors essential to revenue and

costs, should be prepared and properly considered.

" 4° The respective statistics of railway administrations are based on principles suitable to their varying conditions, but the circumstances and conditions of working necessarily differ in different countries, and it is practically impossible to arrive at an absolutely uniform system of operating statistics applicable alike to all countries."

Mr. Timonoff, *vice-president of the 4th section.* (In French.) — The discussion of the question of statistics at the meetings of the 4th section has given the Congress an opportunity to give an opinion about the usefulness or uselessness of noting a tendency towards the unification of railway statistics in the different countries.

Several members have thought that one should not limit one-self to the statement that as the conditions of working of railways differ, statistics should differ equally; but it is necessary that the Congress should show that its ideal would be to see an agreement about this point, between the different countries.

In agreement with several of my colleagues, Messrs. Elsner, Pichler von Deeben, Taris, Biedermann, I propose to add a paragraph in this sense to the conclusions, a paragraph which is worded as follows :

" It is, however, desirable to encourage all efforts towards unification of railway statistics having the object of making possible easy comparisons of the main elements of railway operation in different countries. " (*Applause.*)

Mr. Evelyn Cecil, *vice-president of the 4th section.* — I do not want to discuss in the full session the question which was fully treated in the sectional sitting.

Many of our British and American colleagues are absent on the understanding that a compromise had been arrived at, and would be adhered to, and no notice was given till yesterday that any alteration would be proposed. They could not be aware earlier that Mr. Timonoff desired to add this paragraph. It was only after many difficulties that agreement was obtained upon the four conclusions submitted to the Congress, and these conclusions are the result of a compromise by those present at the full discussion.

Messrs. Fairfax Harrison and Sir Charles Owens, who took an active part in it, are not here. They might reasonably protest against a proceeding which consists of proposing in full session an amendment to the conclusions which was only printed yesterday in the daily journal of the session. If they had known that this new proposal was to be made, they would probably have stayed in Berne.

I ask the Congress in consequence to reject the amendment.

Mr. Hale, American Railway Association. — I regret that so many of the Americans are absent, but I want to say for them and for myself that we understood that the compromise accepted by the section was practically final.

Among the absent American delegates there are many who believe in international statistics but they feel that a proper concession was made by the adoption of the suggestion of Mr. Bloch, in accordance with which the Permanent Commission was asked not to lose sight of the question, but to bring it up again at the next session of the Congress.

Mr. Gooday, Great Eastern Railway, Great Britain. — I beg to say I am in perfect agreement with Mr. Cecil's proposal; as I consider it would be more correct and represent the actual situation if No. 5 were not accepted. I should be glad if Mr. Timonoff would, in this sense, withdraw his proposal.

Mr. Timonoff. (In French.) — I cannot agree to this request. The sole argument brought forward is this : one should not, at the general meeting, make any modifications in the resolutions adopted by the sections.

Now this is quite inaccurate and contrary to the practice of the previous congresses. The general meetings would have no reason for their existence if the decision of the sections merely have to be ratified, pure and simple.

I regret that a certain number of colleagues interested in the question have had to leave Berne, but that is no reason why we should give up discussion at the general meeting. That would be a bad precedent which could be invoked in questions of greater importance. (*Very good.*)

Mr. Evelyn Cecil. — I resist the amendment not merely because certain of my colleagues are absent in view of the compromise, but also because the proposition was not in the least discussed in the section. Several absent members, if they could have anticipated that such a proposal would be moved in the full assembly, would have made a point of coming to resist it. The four conclusions adopted by the section are the result of a compromise, and the fifth which it is desired to add upsets the whole basis of the resolution.

Mr. Colson. (In French.) — As president of the 4th section, I think I must remind you of the conditions under which the conclusions were voted, although I have only semi-officially intervened in the compromise which has just been referred to.

The reason which led the 4th section to reject any proposals having a bearing similar to that of Mr. Timonoff was the extreme difficulty of compiling any statistics which would be really comparable. Personally, I became fully convinced of this difficulty when I tried to make a comparative study of the railways of different countries.

The English railways have statistics which differ materially from those of administrations on the Continent; and the delegates of those railways declared that they would have great difficulty in modifying them.

In America you know that the legislature has given full power to the Interstate Commerce Commission to settle in what form railway statistics are to be kept, and inflicts severe penalties on those who would keep accounts other than those authorized. In order to settle the form of those accounts, there have been very lengthy negociations between the Interstate Commerce Commission and the representatives of the American railways, and it is natural that some of those representatives should feel somewhat alarmed when they see proposals made liable to lead to discussions which may endanger the agreement which has been arrived at with such difficulty.

Other members of the Congress have remarked that the French railways, owing to the conventions existing between them and the State, which gives them a guarantee

for a rate of interest, have in their turn no freedom of action as regards the modification of their system of book-keeping, and their statistics are necessarily based on the rules in force concerning the calculation of the receipts and expenses on which the guarantee is based.

No doubt the resolution proposed by Mr. Timonoff will not be considered very compromising, as it limits itself to the expression of the wish that attempts should be made to uniformize international statistics. Such uniformity would be unquestionably advantageous. The question is whether, if we adopt this resolution, we can hope to arrive at any practical result and whether this wish will not remain purely platonic.

Under these conditions the section did not think it advisable to express a wish of this kind at a meeting of business men, whose deliberations tend to the making of practical improvements rather than the expressing of wishes of a theoretical order.

These are the remarks I wished to make to the Congress, in order to make clear why the 4th section has not added to its conclusions a fifth paragraph of the kind proposed by Mr. Timonoff, altough it has no fundamental objection to the idea expressed by him.

Colonel Bonham Carter, Madras & Southern Mahratta Railway. — I recognize that the Congress has the right to modify the conclusions adopted by the sections and that Mr. Timonoff's proposition would perhaps facilitate the comparison of the statistics, but I think I must mention that a similar proposal has already been made by Mr. Timonoff and that the 4th section did not accept it for the following reasons: a recent law compels the railways of the United States to modify their system of accounts and statistics. A bill is at present being submitted to the British parliament, and if it should be passed, the English companies will be in very much the same position. Finally, you have just been informed how the French railways are situated in this respect.

If conclusion 5 as proposed should be adopted, it would have no effect as regards a large number of companies and would have no use except possibly from an educative point of view. I think therefore that it would be inadvisable to adopt this resolution.

Mr. Evelyn Cecil. — Mr. President, in the circumstances in which we find ourselves, and bearing in mind that the conclusion has not been discussed in the section, it appears to me very difficult to arrive at agreement here. But I do not wish to raise undue difficulties, and I therefore propose the following words upon which I think it might be possible to obtain unanimity :

" 5° It is, however, desirable to encourage efforts towards unification of railway statistics at least so far as the main elements of railway working are concerned, to the extent to which this is possible, having regard to the necessities of each country."

Mr. Timonoff informs me that he agrees to this wording. (*Cheers.*)

The President. (In French.) — As Mr. Timonoff agrees to accept the text proposed by Mr. Evelyn Cecil, and as no remarks are brought forward, I declare this text adopted.

The following are accordingly the

CONCLUSIONS.

" Subject to the particular conditions " affecting railroad accounting resulting " from control of, or financial interest in, " the railways by the State.

" The Congress finds that :

" 1° Statistics, to be of value for operat- " ing purposes, should be made available " for the operating officers at the earliest " practicable date after the performances " of the services for a given period.

" 2° To be of greatest value from an " economical operating standpoint, sta- " tistics prepared for operating officers " should include only such costs as are " directly incurred by the officer inte- " rested, and all indirect costs should be " separated therefrom.

" 3° No one line of statistics should be " exclusively relied upon, but statistics " reflecting all factors essential to reve- " nue and costs, should be prepared and " properly considered.

" 4° The respective statistics of railway " administrations are based on principles " suitable to their varying conditions, but " the circumstances and conditions of " working necessarily differ in different " countries, and it is practically im- " possible to arrive at an absolutely uni- " form system of operating statistics ap- " plicable alike to all countries.

" 5° It is however, desirable to encour- " age efforts towards unification of rail- " way statistics at least so far as the main " elements of railway working are con- " cerned, to the extent to which this is " possible, having regard to the necessi- " ties of each country."

— The conclusions were adopted.

APPENDIX

[313 .385. (01]

MEMORANDUM

By Jean de RICHTER,
ASSISTANT MANAGER OF THE NORTH WESTERN SYSTEM OF THE RUSSIAN STATE RAILWAY.

SUMMARY.

1. — *Author's note and introduction.*

2. — *Principles of statistics of railways in operation.*

a) General remarks.
b) Accounts.
c) Figures relating to maintenance of permanent way and rolling stock.
d) Statistics of the volume and character of the traffic carried.
e) Unit statistics as applied to volume of traffic, etc.
f) Statistics of cost of operation.
g) Statistics relating to indirect and subsidiary services.
h) Other miscellaneous statistics.

3. — *Uniform classification of working expenses.*

4. — *Conclusions.*

5. — *Annexes.*

FIRST PART.

Author's note and introduction.

The Permanent Commission of the Congress, in formulating the programme of each session, and in entrusting the preparation of the various papers to the reporters chosen from among the representatives of the railways of the Association, has been desirous of ensuring their complete independence in the accomplishment of their task. This very liberal proceeding has doubtless produced excellent results; but as a matter of course each reporter, inspired by the ideas and experience of his own country, has endeavoured to bring into special prominence the more salient points

of view of his compatriots. Everything, however, has the defects of its qualities, and this method of procedure has created difficulties when, in the course of the discussions at the Congress, one has found oneself confronted with papers on subjects which, although identical in character, have been treated in absolutely diverse fashion. Although the report on statistics for the European countries, including Russia, has been confided to a special reporter, we feel that we ought not to neglect an opportunity of furnishing our contribution to the study of a question of very great interest being of opinion that in our quality of Russian we can discuss the question with full independence so far as concerns our own country, whilst adopting the programme laid down in the paper of Sir Thomas Rees Price appearing in the *Bulletin of the Railway Congress*, and first in date of the works dealing with railway statistics (1).

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Being without the qualification of reporter, we have not made any inquiries of the Russian administrations, but have simply applied ourselves to the task of placing in evidence the practice followed by the Russian system, comparing it as far as possible with the practice of the British colonial system, between which and the Russian there exists a certain analogy; in point of fact, the Russian government works directly the greater part of the lines, and reserves to itself a considerable share in the management of the affairs of the private companies, to which it often accords its financial guarantee, and over which it exercises a close supervision.

SECOND PART.

Principles of statistics of railways in operation.

a) **General remarks.** — Considerable attention is given by the Russian system to statistics, alike as regards the State Railway and the companies. Certain railways have, indeed, earned distinction in this sphere, notably the former Great South Western Railway Company of Russia, the Kharkoff-Nicolaeff lines, forming today part of the southern Russian state system, and many others which devoted themselves to statistical investigations of all kinds, more than thirty or forty years ago. It would be very interesting to deal with the historic aspect of this evolution; but as space is lacking we will only take into consideration the present state of affairs, characterized rather by a superabundance of statistical work than by a system solidly based and properly unified.

The State system, being under the guidance of three ministries or general managements (ways of communication, finance, and court of accounts) is called upon to prepare special statistics for the use of these different ministries or general managements, independently of the data serving for its own use and recorded

(1) December 1909, p. 1569.

in periodical reports, annual returns, etc. According to a list which we drew up at the beginning of the year 1910, the statistical tables, permanent and temporary, furnished by the administrators of each system amount together to a total of 239 abstracts or vouchers, which may be classified as follows :

	Per cent.
Statistics of balance-sheet : assets	32
— — — : liabilities. . .	8
— — revenue	19
— — expenditure	20
— — results of working.	19
— — accidents.	1
Other data.	1
Total. . .	100

As these statistics play a subordinate part, so to speak, to the tables (I-XI) of general statistics of the Ministry of ways of communication (annex I to the present memorandum) the question arises as to what is their real function. This being, properly speaking, only a systematic division into their constitutive elements of general data bearing upon the annual finance and general results of each system (treated as a unit), we arrive at a classification of the elements as follows :

		Per cent.
1.	Analysis of length and area of surfaces.	15
2.	— of inventory	32
3.	— of staff.	6
4.	— of traffic.	13
5.	— of directions of traffic (up and down)	4
6.	— of accidents.	3
7.	— of duration of commercial or technical transactions . . .	25
8.	— of other elements	2
	Total. . .	100

With a view to facilitating the study of a question already very complicated by its nature and by the number of elements entering into its composition, we commence by dividing the corresponding data into *permanent* statistics and *temporary* statistics, following the example of Sir Thomas Rees Price.

Permanent statistics.

The permanent statistics, comprising, in accordance with the formula of Sir Thomas Rees Price, the actual results, abstracted, grouped, and presented when once the operations concerned are over, are more especially those which relate to annual periods and are recorded in the returns of the ministries of communications, of finance, and of the managements of each individual system for the financial period entering the space of a complete year.

In our report on the question of railway accounts, contributed to the seventh session of the Congress (question XIV), we have already furnished a general idea of the statistical items chronicled in the returns (1), dwelling upon their extreme complexity and lack of unity. In taking up again, the same subject on the lines adopted by Sir Thomas Rees Price, we hope to make more clearly evident all that is defective in the present system of Russian railway statistics.

Temporary statistics.

According to a table prepared by us at the beginning of the year 1910, the number of temporary statistics reaches the very

(1) Appendix VI to our report (see *Bulletin of the Railway Congress* 1905, March, p. 1037, and *Proceedings of the seventh session* [Washington, 1905], vol. 3, p. XIV-149).

considerable total of 139 abstracts or vouchers, including: *a*) generalities, 4; *b*) finance and accounts, 31; *c*) ways and works, 4; *d*) rolling stock and workshops, 22; *e*) methods of correspondence (post, telegraph, telephone, signals, etc.), 2; *f*) stores, 5; *g*) staff, 21; *h*) commercial and technical working, 44; *i*) accidents, damages, losses, etc., 4.

According to the dates of their presentation, these statistical data are classed in the following fashion: *a*) accidental, *i.e.*, presented as the need may happen to arise, 18; *b*) daily, 5; *c*) weekly, 1; *d*) presented fortnightly, 3; *e*) monthly, 61; *f*) quarterly, 4; *g*) half-yearly, 22; *h*) annually (without entering into the category of permanent statistics), 36; or in all (without counting the data of an accidental character), 2,773 abstracts per annum.

It would be useless to enter into the details of temporary statistics which are remarkable only by their absolute lack of cohesion. We confine ourselves, therefore, to pointing out that a scheme of temporary statistics, based on a general view, is now in preparation, a scheme of which we give a brief idea in annex III to our memorandum.

Establishment and balance-sheet accounts.

b) **Accounts.** — As no one doubted the great importance attaching to an exact knowledge of the expenditure necessitated by the construction and improvement of railway systems, a commission, appointed in 1884, introduced a classification of the figures relating to the establishment expenses and the balance-sheet of railway companies, forming annexes IX to XIV to our report on the question of accounts. These establishment expenses are, however, only imperfectly known, and are not always found recorded in the balance-sheets of the undertaking, especially after the buying-up of a considerable number of privately-owned railways and the successive grouping of these lines among the different systems of the State. This deplorable confusion has been aggravated by the practice of debiting establishment accounts with fictitious items of interest added to the expenditure effected upon the resources of the revenue or State budget, where the obligation of paying interest for the use of the capital was in no way demonstrated. It is due to this circumstance that wholly erroneous conclusions have been arrived at concerning the financial results of the working, a fact which has lately been established by a commission of inquiry appointed by the Russian government in 1908. Thus the value of the balance-sheet appended to the returns of the State systems, where the subject has never received the attention to which it was entitled, is practically nil. The liabilities being surcharged with fictitious expenditure, the assets do not admit of a detailed analysis of the real value indicated by the inventory, in which the cost of the permanent way and constructive works, buildings, etc., is found burdened with the value of rolling stock, general expenses and costs of consolidation of capital, stocks in warehouse, etc.

It is only from 1 January 1911 that the government has introduced a uniform type of balance-sheet for the whole State system.

If there is one thing the importance of which is thoroughly understood in Russia, it is the necessity for an exact classification of receipts and expenses, uni-

form for the whole system operated by the State and the companies. All the headings of the budget have been fixed by a commission appointed by the government in 1884 (1), and this nomenclature is recorded in annex III to our report upon Russian railways accounts. But this uniformity of classification in no way implies the material unity of the accounts, since a great difference exists between the methods of charging revenue and expenditure in force upon the State lines and those of the companies. The State systems count as revenue or expenditure only the money actually received in cash or expended, a vicious practice borrowed from the government accounts, whereas the companies enter, and rightly so, as Sir Thomas Rees Price remarks, all the receipts and all the expenses appropriated, whether received or not, a method which alone responds to the principles of sound book-keeping. This difference in the method of charging involves, at the same time, another difference : the closing of the budget, which occurs on the State system three months after the expiration of the financial year, takes place in the case of the companies only at or about the moment of the settlement of the report and accounts for the financial year, *i. e.* at a period much more remote. We may here remark that we have no objection to raise with regard to the desiderata urged by the reporter in paragraphs 1, 2, 3, 4, 5, 6, 7. pages 12 to 14, of his paper.

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ings.

Receipts. — We believe that the classification of receipts, given in annex III to our report on accounts (scheme of traffic budget) corresponds in fairly exact fashion to the wishes expressed by Sir Thomas Rees Price.

Classification of working expenditure.

Expenditure. — We have given in annex III to our paper on accounts our classification of expenditure, which does not differ greatly from the ideas of the honourable reporter. It goes without saying that, applied to systems of lesser importance, this classification involves a certain excess of detail, and a commission, instituted by the government — a commission whose labours are drawing to a close — has proposed to eliminate from the present classification headings of a secondary importance, which will diminish by about two-thirds the number of items in the budget of expenditure.

General statistical data on the construction and working of the Russian railways.

Before entering into the details of the data recorded by Sir Thomas Rees Price, on pages 16 and 17 of his report, we think it well to give a general idea of the particulars contained in eleven tables of an annual statistical miscellany, prepared by the ministry of ways of communication upon the basis of special data furnished by the managements of each system.

Annex I to the present memorandum.

I. Financial position of the railways at the end of the year (38).

II. Length of railways in regular operation at the end of the year, constructed, operated, length of application of tariff, and virtual length by sections, with indication of the year of construction (9).

III. Rolling stock of the railways :

A. Stock of locomotives upon the railways at the close of the year, with indication of their number, their type, method of

(1) See page 151 of our report (*Bulletin of the Railway Congress*, 1905, March, p. 1039).

heating according to fuel, and system of brakes.

B and *C*. Stock of carriages and goods wagons on the railways at the end of the year, with indication of number, design and cost (131).

IV. Effective force of the staff and its maintenance on the railways.

V. Mileage of the rolling stock on the railways during the year (78).

VI. Number, mileage and composition of trains during the year, with analysis according to fast, ordinary and slow trains, per month (93).

VII. Traffic and gross receipts during the year, with analysis per month of the total passenger traffic, according to the general tariff for goods by slow-freight trains and the total gross receipts (188).

VIII. Working expenses during the year (146).

IX. General results of the working and traffic, during the year (89).

X. Accidents during the year (80).

XI. Number of persons affected by accidents during the year (93).

(See annex I to the present memorandum).

Annex II to the present memorandum.

With regard to the schemes elaborated by the commission of 1884, these include ten tables forming an annex to the returns for the financial year, *viz.* :

I. General data regarding the line, including an indication of the date of the concession, the opening, and likewise the length of the working and application of tariffs.

II. Total length of main lines, secondary lines, and branch lines belonging to the company and to third parties.

III. Data regarding rails and sleepers.

IV. Data regarding the permanent way and the number of constructive works, level crossings and accessories of the permanent way, situated outside the stations.

V. Data regarding the lands acquired for the construction of the line, the number and description of the buildings and their appendages.

VI and VII. Data concerning the number and type of locomotives, carriages and wagons, and of installations for their upkeep and repair.

VIII. Data regarding the number and stocks of tools of the central and auxiliary workshops.

IX. Data regarding commercial transport capacity.

X. Data relative to the traffic, revenue, and mileages of the rolling stock.

(See annex II to the present memorandum).

The commission of 1884, in formulating this programme, left to the ministry of ways of communication and to the general Russian railway association the task of completing it by a series of supplementary tables of a " technical or administrative " character.

The general association concerns itself very little with the matter. As to the ministry of ways of communication, it hands over the task to the general management of the State railway and to the boards of directors of the privately-owned railways.

Neither the one nor the other devotes

to this work the care demanded by the importance of the subject. As to the practice of the administrations of each individual system, the question is disposed of in a rather unexpected fashion. The statistical tables of the commission of 1884 are buried under a mass of miscellaneous particulars having no apparent link with the programme of the commission of 1884, of which there remain today only certain fragments and that medley of forms and annexes to the returns which we have recorded in our report on Russian railway accounts (*Bulletin* of March 1905). (See annex VI.)

These particulars of a general character being given, we take up again the thread of our inquiry, following the programme outlined by Sir Thomas Rees Price, with the object of entering into greater detail. From this time, then, let us occupy ourselves only with the data recorded in the annual traffic returns issued by the managements of each system, independently of the general data published by the ministries of ways of communication and finance.

Statistics of assets.

c) **Figures relating to maintenance of permanent way and rolling stock.** — We have already dwelt upon the defects in the first establishment accounts, for which the commission of 1884 furnished, nevertheless, a fairly detailed model. Unfortunately, a large portion of the present system was then already constructed, and the rules and regulations elaborated by the commission (except as regards the classification of receipts and working expenses) not receiving any sanction, no one believed it necessary to take heed of the counsels given. Not only did the private railways continue to act in this way, but the State system, whose accounts were always very much in arrears, did the same. A good deal of the responsibility for such a condition of affairs rests upon the system of accounts adopted by the State, which is based solely upon the operations of cash finance, and still more upon the out-of-date organization of the accountant-general's office in matters relative to the administration of railways.

If such are the characteristic features of the establishment accounts (and of the corresponding portion of the balance-sheet), nothing is more natural than the insufficiency or defectiveness of the statistical details furnished by the returns of each administration. Here are the elements we which have found again among the particulars furnished by the State system and the companies.

Permanent way and accessories. — General data. — By way of explanatory note and entry for the subject, a statement is made of the length, highest point, steepest gradient, radius of sharpest curve, virtual length and average cost of each system, including general workshops, rolling stock, etc.

System belonging to the administration. — Table indicating the mileage of single, double and triple track, and of sidings, etc., together with the equivalents in single-track mileage for the whole system or by sections, according to circumstances.

Average mileage operated. — This information is likewise recorded in the returns for the financial year.

Rails in track. — Table showing for each section the total mileage of rails of each type, according to weight, length per unit, and date when laid.

Sleepers. — Statement showing for each section the number of sleepers of each sort and the period they have been in use, without indication of the corresponding mileage or of the number per verst, etc.

Rail fastenings. — Statement showing for each section the type of attachment, without indication of the mileage of line or age.

Ballast. — Statement showing the nature, depth, etc. of the ballast used, without indication of the mileage of the line on which it is used.

Bridges, tunnels and other constructive works. — Dimensions and capacity, without indication of the cost for each section.

Reservoirs and dams. — Nil.

Hoisting plant. — Certain data (without indication of price) and only for the workshops for the repair of rolling stock.

Coaling plant. — Nil.

Station and other buildings used for railway purposes. — Particulars for each section and station, under classes, but without indication of cost.

Signalling appliances. — Particulars for each section and station, under classes of signals, but without indication of cost.

Land acquired for railway purposes. — Nil.

Locomotives and rolling stock. — Locomotives. — All the particulars mentioned by Sir Thomas Rees Price are given under the separate types.

Coaching stock. — Ditto.

Goods stock. — Ditto.

Workshops and other plant and machinery. — Ditto, except as regards the age and cost of plant.

As regards the condition of the plant and equipment, belonging to the statements of account and the temporary statistics, the indications given are sufficiently detailed to meet in an adequate way the suggestions of the reporter.

d) **Statistics of the volume and character of the traffic carried.** — This is, perhaps, the most highly-organized section of the whole of the Russian railway statistics. Centralized in the ministry of finance, to which belongs the supreme direction of the tariff arrangements of the whole system (State and companies), this portion of the statistics, arranged upon a plan marvellously complete, clear and uniform, is yet of little practical value, since the data, published more than a year after the close of the financial period, clearly cannot serve as a guide in the conduct of current affairs, in regard to which it is necessary to come to a decision based upon temporary statistics gathered together for the occasion.

A. Statistics published by the administrations of each system.

In accordance with an instruction approved by the minister of finance relative to the establishment and publication of traffic statistics, all the railways of the Empire (State and companies) are obliged to keep detailed statistics of the traffic in passengers, luggage and goods by quick freight and slow freight.

The passenger statistics are based upon a classification of passengers and luggage according to scales, whilst the goods are divided into three categories (I, II, III) and under 129 distinct headings.

These statistics, prepared by the administration of each system, are published in the form of annual miscellanies :

I. Statistics of the commercial goods

traffic, slow freight of the 1st, 2nd and 3rd categories, with the exception of cereals and of all goods by fast and ordinary services, conveyed by passenger and mixed trains "at departure" by each station of the system.

This statement includes particulars of the consignments from all the stations of the line in question and for all the goods in conformity with the classification, grouped into certain categories. It further includes columns in which are recorded transports by the piece and live stock.

These statistics include the following details :

1° Name of sending station;
2° Route;
3° Name of receiving line;
4° Name of receiving station;
5° Volume of goods :
a) Consigned to stations of the system proper, and to other lines;
b) Total for each receiving line;
c) Total per sending station.

II. Particulars of the transports of cereals "on departure" from each system of the station proper. This group of figures contains data concerning the dispatch of all cereals, divided into four categories :

a) Corn;
b) Flour, groats, malt and oatmeal;
c) Bran and residues;
d) Seeds.

In accordance with this classification of goods, the tables contain thirty-seven columns, and the particulars entered therein are classed according to :

1° Sending stations;
2° Points of exchange of goods;
3° Receiving lines;
4° Receiving stations.

The statement includes the totals for each category and for the whole (general total) "on departure".

III. Statistical statement of the commercial activity of the system, containing general abstracts of the passenger, luggage and goods traffic by all classes of trains per annum.

This collection of figures includes the following particulars :

1° General survey of the commercial activity of the system;

2° Table showing the number of passengers and the volume of luggage and goods by quick freight and slow freight per month, a comparison being made between the figures for the current financial year and those of the preceding years;

3° Table showing the passanger, luggage and goods traffic by the local service "on departure", "on arrival", and "in transit", as compared with the figures of the three preceding years;

4° Table of station operations "at departure" and "on arrival" of passengers and of goods by quick and slow freight;

5° Table of service traffic, with groups and headings for the classification of commercial goods, a comparison being shown with the figures of the preceding years;

6° Table dealing with the number of luggage-tickets and way-bills of goods by quick and slow freight according to station, as compared with the figures of the preceding years, and

7° Table of the traffic in all commercial goods (including the service traffic affected to the account of special funds) indicating the corresponding stations.

IV. Besides the collections of figures above, mentioned and appearing each year, there was published till 1905, a statement showing the traffic in all goods by quick and slow freight "on arrival" and "in transit".

Beginning with 1905, this publication was abolished for reasons of economy, only two copies of the statement being set up, one of these being kept by the administration of the system and the other presented to the ministry of finance.

The figures of the goods traffic " on arrival " and " in transit ", as well as those " at departure ", are prepared according to the classification of the goods by groups of names and by headings, the following information being furnished :

a) *Arrival.* — 1° Receiving station; 2° route; 3° sending lines; 4° sending stations, and 5° weight of goods (poods) " on arrival ", the corresponding figures being given per sending stations of the home system and other lines, together with the total arrivals per receiving station.

b) *Transit.* — 1° Sending lines : 2° points of junction with home system ; 3° receiving lines and 4° number of poods (weight of goods) " on arrival " and " at departure " from each line.

There is a question of renewing, to begin from 1909, the publication of returns of figures " on arrival " and " in transit ", in the style of the collection " on departure " and " in transit ".

On the basis of the statistical data above set forth and transmitted by the managements of each system, together with the supplementary information furnished by the latter at the will of the ministry of finance, the latter publishes every year the following statistical reports :

A. — *Passenger traffic.*

B. Figures issued by the ministry of finance. *a*) Annual publications.

Three collections of figures deal with passengers and their luggage. The first contains the figures " at departure ", the second those " on arrival " and " in transit ", and the third the total passenger returns for the financial year.

Each collection contains the corresponding data consigned to special tables, as follows :

1. Data of each itinerary, followed by the number of journeys according to classes of ticket and fares.

2. Abstract of stations with totals of passengers at ordinary and suburban rates.

3. Principal points of departure of passengers (ordinary suburban rates) exceeding 100,000 journeys per annum.

4. Classification of departure totals of each line per zone at ordinary fares.

5. Ditto at suburban fares.

6. Classification of passenger mileages per zone and average mileages at ordinary fares.

7. Ditto at the suburban rate.

8. Classification of receipts (in roubles) from passenger traffic per zone and at ordinary fares.

9. Ditto at the suburban rate.

10. Classification of the departure totals according to category of suburban service tickets, with an indication of the number of passengers and the receipts.

11. Weight of luggage and parcels dispatched.

12. Classification per zone of journeys effected at ordinary fares " on departure " from the most important points, starting from 100,000 journeys.

13. Percentages of seats available and occupied at ordinary and suburban fares for ten consecutive years.

14. Costs of transport by railway : *a*) totals for the whole system in millions of roubles; *b*) ditto per verst of length; *c*) per unit of mileage (passenger-versts and pood-versts)

15. Statement of the number of passengers and the receipts for each section of

the system between two stations of the suburban service.

16. Figures showing supplementary receipts for celerity, numbered seats and certain facilities upon the Russian system.

B. — *Goods traffic.*

This group of figures comprises data relative to the principal goods classed in forty-eight annual official reports. Three of the reports are devoted to the traffic in cereals, one includes general data of the traffic in all goods of the 1st and 2nd categories, and one contains the general totals of all goods traffic.

The statistical data of these official reports are grouped in tables as follows :

1. The most important stations and lines " at departure " and " on arrival ".

2. Distribution of the traffic per forwarding and receiving lines.

3. Statistics " at departure " for each line, with elimination of the departures from foreign lines, from the Russian maritime ports and from the ports of the Volga.

4. Statistics " on arrival " for each line and indicating the arrivals by foreign lines, from the Russian maritime ports and from the ports of the Volga.

The preface to each official report indicates the general totals of the corresponding traffic for the financial year and for the five years preceding.

Triennial publications.

Independently of the three collections of figures dealing with the passenger traffic and the forty-eight articles of goods, the ministry of finance issues periodical statements, spread ever three consecutive years, relative to the goods traffic.

These collections of figures, to the number of twenty, contain statistical data " at departure " and " on arrival " of goods of lesser importance, forming part of the official classification. The grouping of the data of these triennial statements is similar to that published each year.

C. Statistics published by the ministry of ways of communication.

But we have not yet recorded all the official traffic statistics.

The ministry of ways of communication also concerns itself with goods-traffic statistics, and issues an annual statement in accordance with the following programme :

1. Consignments and arrivals of cereals and other principal goods by slow freight per station.

2. Consignments and arrivals of the whole of the goods by slow freight per station, and their mileages between the consecutive stations according to the direction of the traffic (up and down).

3. Analysis of dispatch and arrival of principal goods and of total goods by slow freight according to mode of transport and railway mileages.

Unit statistics.

e) **Unit statistics as applied to volume of traffic carried, traffic earnings and utilization of rolling stock.** — The use of statistical units is widely spread over the Russian system, the very earliest railways having employed the length of the track and the mileages of trains and rolling stock as a measure of the operations effected. Subsequently there were added data as to the number of units of traffic and several others, a complete enumeration of which will be found in table X drawn up by the commission of 1884. (Data relative to traffic, receipts and mileages of rolling stock.)

Train-versts.

Table X contains the following particulars regarding train-versts :

General mileages of all trains, mileages of fast and ordinary trains, including :

a) *Special :* imperial trains; private trains; service trains;

b) *Regular :* express trains; mail and passenger trains; mixed trains; military trains; optional trains (passenger).

Mileages of slow-freight trains, including :

Goods trains; military trains; service trains.

After the fashion adopted on the British colonial system, the traffic earnings are brought into relationship with the corresponding mileages of fast, ordinary and slow trains, and with the total train mileages; but the calculation of the scale of fares could not be based solely upon such data : account has to be taken not only of the passenger and goods mileages, but also of their classification according to the relative nature of the traffic, the average distance, the direction of the traffic, and many other considerations, too numerous to be set forth in this outline of the practice.

Passenger-versts and pood-versts.

The same table (X) contains the following data concerning units of traffic mileages :

Total mileages of passengers.
Total service mileages.
Total mileages of luggage.
Total mileages of parcels.
Total traffic mileages per piece.
Total mileages of animals.
Total mileages of goods by slow freight; up traffic; down traffic.
Total traffic mileages.
Total mileages of animals.
Total service mileages.

These particulars are supplemented by an indication of the average distance covered, and the receipts per unit distance. They are further divided according to the classification of the objects conveyed, but no account is taken of them in the general conclusions of table X, to which are referred :

The mileage of the tare (weight) of stock employed, divided into :

Mileage of the tare of locomotives and tenders;

Mileage of the tare of vehicles (carriages and wagons), showing the tare related to the mileage unit of each train and of 10,000 vehicles.

The general conclusions of this table are presented in the following fashion :

Average load of each carriage axle (number of passengers).

Ratio of the average number of available and occupied seats to each carriage axle.

Average number of passengers in each train.

Average load of each wagon axle (number of poods).

Average number of poods in each goods train.

Ratio of the effective average load of each wagon axle to the transport capacity of the corresponding stock.

Ratios of the total mileages of wagons loaded and empty.

Gross mileage of the whole rolling stock and of the whole traffic by quick and slow freight.

With regard to the latter figure, it is to be regretted that a distinction has not

been introduced between ordinary and slow trains.

Zone tistics.

We have already referred to zone traffic statistics in our statement concerning the statistics of the volume and nature of traffic.

verage aul.

The figures relating to the average distance hauled are given in table X independently of the zone statistics, in connection with the statistics of the volume and nature of the traffic (see above).

Like those of the British colonial system, the Russian statistics also give the earnings for passengers and freight per verst of line operated.

Train oads.

Passing next to the consideration of the figures relating to the utilization of rolling stock, it should be at once understood that this is a question the importance of which is well understood by the managers and other heads of the Russian system. The question has, in fact, been before them since 1884, since the commission previously mentioned then occupied itself with it, drafting an abstract of wagon mileages per *month* and per *direction* of traffic. It was this commission, also, which added to the conclusions of table X the reference to the average load of each carriage axle as well as each wagon axle, without, however, appropriating them to the different *sections* of lines or to the *months* of the traffic.

In spite of the plethora of statistical data, with regard to mileage of stock and mileage of traffic alike, there is too sensible a difference in the organization of their elements to render it possible to relate them to each other. The fact is that the parallel data, by defect of agreement as much with regard to the sections of the system as to the periods of the year (months) and the directions of the traffic (up and down), scarcely lend themselves to proper conclusions. As this question is still under consideration, we confine ourselves to indicating the points which may be regarded as settled. There is first of all the principle of the parallelism or uniformity of the classification of mileages, as much for rolling stock as for traffic. The ideal would no doubt be found in the study of the work actually accomplished by each kind of stock which has served for the transport of such a class of passengers or kind of goods, in such a month of the year, upon such a section of the system, in such a direction of traffic.

Unfortunately, so detailed a comparison between mileages, stock and traffic would involve an increase of work and expense out of all proportion to the results to be obtained. The question, then, is to find a line of demarcation with a view to deciding the question in as liberal a fashion as the circumstances permit. As Russia transports a great quantity of cereals and other non-manufactured articles, it is clear that fluctuations of traffic must be very frequent, and that the period for the registration of corresponding data ought not to exceed one month. Statistics of the utilization of stock should, then, be monthly. As to the sections of the system, the point is more difficult to settle, in view to the very great difference in the bulk of traffic per unit of length. The simplest plan would be to bring together the statistical elements (mileages of stock and mileages of traffic) for each portion of

the system situated between two neighbouring stations and in the two directions of traffic separately, subject to combining the product of these sections according to the varying needs of the service. We are, then, absolutely in agreement with Sir Thomas Rees Price when he says " that the value of the information as an aid to operation would be much greater *were the figures given* separately *for each section, for up and down traffic*, and for traffic *between specially important points on the system*". This is precisely what we ourselves set out to do (since 1884) in carrying forward all these data to each month of the financial year, with a classification of the traffic and stock employed in more or less detail, according to the requirements of the service. A monthly analysis is so much the more urgent that the costs of working vary a good deal by reason of the degree of utilization of stock, that our budgetary legislation admits of many variable credits (according to the units of traffic), and that we are obliged to draw up monthly statements of credits in view of a periodical control of the execution of the budget, organized upon all the State systems and those of the companies.

Efficiency and utilization of locomotives and rolling stock.

Statistics of train mileages are kept by all the Russian railways, and show separately :

Mileages of commercial trains :

Fast trains : Imperial trains; express trains; postal and passenger trains; mixed trains; special trains; total fast-train mileages.

Slow trains : goods trains; service trains; total slow-train mileages.

Military : troop trains; hospital trains; supply trains (equipment, stores, etc.); total military mileages.

Administration : fuel trains; building-material trains; ballast trains; trains carrying earth and snow; total administrative mileages; general total of mileages of trains of all descriptions.

As to locomotive mileages, these are classed according to the following categories :

I. *Remunerated :* passenger trains and mixed trains (fast and ordinary); goods trains (slow freight); military trains; service trains; double-headed trains.

II. *Non-remunerated :* light; reserve; station service.

The shunting mileages (station service) are calculated upon basis of a uniform speed of 5 versts (3·3 miles) per hour.

The mileage figures above set forth are recorded monthly and show the totals of four successive years, with an indication of the average composition of each of the three great categories (number of cars and number of axles) together with the total average mileage per day and per unit lenght (verst) of the system. The proportions per cent of the different categories of train mileage are also mentioned. A special table shows the locomotive mileages for each series (type) during four successive years, subdividing them into mileage remunerated, total and average, separately for locomotives actually utilized and for the totality of the inventory, and at the same time indicating the maximum mileage of each locomotive forming part of each given series.

Finally, a brief accqunt is given, for each month of the financial year and the total

of four successive years, of the mileages of the locomotives per section and per month, for each of the categories of trains mentioned above.

But the gross ton-miles (pood-versts) hauled per locomotive and per type are not obtained, owing to a lack of unanimity in the organization of the traffic statistics, and all one is able to do is to calculate (for the whole financial year) the average load of each category of train, alike as regards cars, axles and units of traffic, taking no account of sections of system, months, etc.

There is also kept in the case of each locomotive, mileage statistics giving the dates of the reports presented by each engine-driver at the time of his return to the sheds, during the whole period the locomotive remains in service.

ileage oads.

We have already indicated the theoretical value attached by the Russian railways to exact data regarding the utilization of passenger and goods cars alike.

Unfortunately, as we have just pointed out, for lack of a proper agreement between the data, it is not practicable to furnish statistics per month, per section, per direction of traffic, and per kind of stock employed and traffic effected. With regard to the corresponding figures, which are obtained for the whole system and for the whole year, they are of very slight value from the statistical point of view since no account is ever taken of the bad or good utilization of the stock, and one cannot, therefore, derive any information from them.

We are, then, entirely in agreement with the reporter as to the necessity of co-ordinating these data henceforth in a fashion much more precise than is the case today.

As regards the utilization of carriages of different classes and the average load for each class taken separately, the figures are set up for each financial year, since the carriage mileages are recorded per month and in special abstracts, even for each train taken separately, that is to say in the most detailed fashion possible. It is regrettable that these figures, transferred by us to the temporary statistics, should not be reproduced in the tables inserted in the annual returns.

As to the utilization of goods wagons, the annual returns set forth the car mileage separately for covered stock, open trucks, fuel trucks, ballast trucks, and tank trucks for the transport of naphtha ; not only for the whole system and per month, but also by series of trains : passenger, goods, military and service.

But these data are not brought into comparison, as we have just pointed out, with those of the traffic mileage, except in their totals for an entire year and for the whole system.

f) **Statistics of cost of operation.** — Although we share the opinion of the reporter as to the importance of statistics of expenditure, classed according to the operations and not according to departments or administrative services, we do not think it possible to change the classification of the budget of expenditure in accordance with these principles, seeing that this portion of the budget represents an instrument of government, the service chiefs acting as directors of expenditure. It is, however, through the departmental classification that so much dif-

ficulty arises in rendering account of the costs of the various traffic operations, whereas it is an easy matter to fix the corresponding receipts (or, at least, the average receipts), which are classed by operations and not by departments.

Il is true that the budget of expenditure, classed by departments, includes also a considerable number of subdivisions corresponding to the various items of reveue; but these particulars are scattered about among the different headings, sections, etc. It would be necessary, therefore, as a preliminary step to bring them together, which would involve extra work and appreciable loss of time, to say nothing of the differences of opinion as to the method of co-ordinating them (see annex III to our report on the question of accounts).

The task of settling questions which relate to good management of railways is a difficult one. The Russian State system has just had painful experience of that fact. With a doubtful establishment account, and with the liabilities in the balance-sheet surcharged with figures merely estimated and to a considerable extent of a fictitious value, and burdened, moreover, with the cost of a great strategic line like that of Eastern Asia, the State system will not so soon be able, in view of the special and political character of its operations, to cover the capital charges of original establishment and subsequent improvements, or often even the working expenses.

The system has nevertheless rendered the State immense service, during recent years, in the exportation of cereals and in considerable transports of soldiers and emigrants, despite innumerable difficulties and under the pressure of invariably hostile criticism.

These service complications place us in a position to appreciate all that is true in the opinion expressed by Sir Thomas Rees Price that an increase of expenditure (even if accompanied by a decrease in the train mileage) does not necessarily imply bad working. It is therefore of the highest importance that the accounts should be presented in a form easy to grasp, and that the unit statistics should be appropriated to their proper end and be sufficiently complete to admit of correct deductions being arrived at without too much difficulty. From this point of view, we accept unhesitatingly a classification of expenditure into :

1. Maintenance of way and works;
2. Maintenance of equipment (locomotives and rolling stock);
3. Transportation, *i. e.* running expenses;
4. Traffic, properly so-called;
5. General charges, which are of a universal character; although not corresponding exactly with the different departments of the service (see annex III to our paper on the question of accounts).

In accordance with the methods indicated by Sir Thomas Rees Price, we also reduce the expenditure to averages per unit, such as the verst of lines open, ditto per verst of single main line, 100 train-versts, 1,000 locomotive-versts, 10,000 axle-versts of passenger stock, ditto of goods stock, ditto total, 1,000 passenger-versts, 1,000 pood-versts, in proportions per cent of the earnings, ditto of the total expenditure without counting the units of a more particular order, such as the num-

ber of stations and yards, the site areas of buildings, yards, etc.

Statistics of staff employed.

Much attention is given in Russia to statistics of the railway staff. The returns include a table giving a very detailed enumeration, and for each department or service separately in respect of the different grades, the effective force of the staff employed and the remuneration for each financial year, a comparison being made with the budget estimates and not with those of the previous period, which would be of much greater utility. Comparisons between the different periods and with other railways are therefore always practicable, although involving a rather considerable loss of time.

There is also a general summing-up of the effective force of the staff and its remuneration in the general statistical statement of the ministry of ways of communications (annex I to the present memorandum), greatly facilitating a comparison of the condition of the staff upon the various systems.

Sectional figures of expenditure.

Although highly appreciating the practical value of monthly statistics according to sections, as an element of emulation between staffs directing certain portions of the system, we have nothing in any way comparing with the model given in the annex to the report of Sir Thomas Rees Price. It is only with great difficulty that we have got to the point of compiling monthly data for each system, and even now in many respects the figures are open to the charge of being merely provisional. As a consequence of the very complicated method of liquidation of accounts under our extremely bureaucratic and red-tape system of control (see our report on the question of accounts, in the seventh session) definitive figures cannot be complied without the loss of a good deal of time.

We possess, however, nearly all the elements required for the drawing-up of tables by sections, and have no objection to bring forward against the method of apportionment of expenditure among the different divisions described by the reporter.

Division of expenses between passenger and goods services. General remarks.

There is general agreement, in Russia, as to the utility of the division of expenditure between the passenger and goods services, and this division, in accordance with a form approved by the ministry of ways of communication, has been made regularly since 1895 in table IX of the official record of railway statistics of the Empire (State and companies) although the general practice takes little enough account of this great work, the bases of which were established in former days, after a minute enquiry, by Mr. Gortschakoff, engineer of ways of communication, member of the commission of 1884, and today inspector-general of the Russian railways.

As Sir Thomas Rees Price remarks, the question of apportioning expenditure between the passenger and goods services is of a controversial character, and the method applied upon the various systems of the world do not differ in too pronounced a fashion.

We give a detailed idea of the official Russian method of apportionment in table IX (see annex I to our memorandum). Without entering into further detail, let us confine ourselves to reproducing some observations of the late

Mr. Saloff, former president of the higher technical council of the ministry of ways of communication, an author whose great competence will not be disputed by any of those who have the good fortune to be brought into contact with this rare and lofty spirit. This is the manner in which Mr. Saloff expressed himself:

" The statistical record of the ministry of ways of communication establishes a division of expenditure between two categories of trains, one of which comprises goods trains and service trains, and the other the whole of the remaining trains. The expenses of the first category are reduced to pood-versts, those of the second category to passenger-versts, the mileages of luggage and parcels being reduced to passenger-versts in the proportion of the revenue. This method of calculation cannot be held as rational, seeing that : 1° the reduction of luggage and parcels carried by fast train into pood-versts in proportion to the receipts does not correspond with the costs of transport which differ greatly; 2° the fast and ordinary trains also include luggage-vans and special vans the expenses of which ought not to burden the costs of passenger traffic; 3° the passengers carried on service are not counted. But one can obtain results almost as precise, and with much less complication, by dividing up the sum total of the working expenses according to the axle-mileage of the vehicles, employing certain coefficients for the passenger stock and the goods stock."

It results from the calculations made by Mr. Saloff that the cost of three passenger-carriage axles corresponds almost exactly with the cost of four goods-wagon axles. These approximate figures are confirmed by a much more detailed analysis of the corresponding expenses.

After these declarations of a general character, we pass to an examination of the working of the different branches of the service, still following the line traced by the honourable reporter.

But before entering fully into the matter, and to avoid all confusion in the examination of so complex a question, do not let it be forgotten that the point under consideration is the distribution of expenses based upon the classification of headings of the budget of expenditure.

These headings, in accordance with the scheme of 1884, are 322 in number. Conformably with the regulations concerning to annual returns of 1884, each credit (or item of expenditure) should be divided into costs of administration, costs of labour, and costs of stock, including spares, which would bring the number of elements up to a minimum number of 966, As for each article it is necessary, at least, to give the number, the kind, and the net cost, we reach already a classification of no less than 2,898 constitutive elements. Since each element, again, can be divided according to its nature, into an infinite number of others (each such product comprising dozens of categories of labour and materials), we arrive at an extraordinary complication in endeavouring to analyse each of the 322 headings of the budget of expenditure.

Accordingly the commission of 1884 limited itself to impressing upon the railways the duty of furnishing in their reports and accounts *explanations reproducing full details of the composition of each item of revenue and expenditure* (see our report on accounts to the seventh

session), leaving to the general association of railways or to the managements of the systems the creation of the corresponding model forms. We have already pointed out to what this free way of dealing with the matter led. Desirous at all costs of putting an end to the existing state of affairs, a commission which has just been appointed for the establishment of a new classification of expenses and their auditing has stopped at the setting-up of a special table for each of the 148 items of the new classification. It is from this work that we borrow the elements necessary for a comparison of our organization with the data of the reporter.

Main-enance of way, orks and tations.

Maintenance of way, works and stations. — These costs of maintenance are worked out per verst of the length of the system and per verst of main line (single), without indication whether the sidings are included. The maintenance of the rails is related, further, to the gross pood-verst. There is also given the percentage of the costs of maintenance to the sum total of the expenditure of the service of way and works. With regard to the special data concerning the items set out under this heading by the reporter (ballast, sleepers, rails, relaying, extraordinary expenditure for maintenance, bridges, stations and buildings) we do not bring these specially under the notice of the reader, since their distribution is, to all intents and purposes, the same as for the remainder of the items of the budget.

Let us content ourselves with indicating that there is always included a comparison between five successive years, which renders it sufficiently obvious if the figures appreciably differ from the average. Should such be the case, detailled explanations have to be furnished.

Maintenance of rolling stock.

Maintenance of locomotives. — The costs are worked out per total locomotive-verst without any distinction being made between fast, ordinary and slow services. Statistics are always kept of the mileage effected by each locomotive per month, together with the costs for repairs of each locomotive, and periodical or temporary statistics, of which we have spoken earlier, as to the number of locomotives partly or generally repaired, with an indication according to class of the repairs effected.

At the same time, the expenses are divided into costs of repair of locomotives and repair of tenders, there being shown, on the one hand, the costs of locomotives in regard to boilers, frames, gear and other parts, painting; and, on the other hand, the costs of repair of tenders, of water-tanks, etc., and painting.

Passenger stock. Maintenance. — The costs are worked out per carriage-mile and per axle-mile.

As in the case of locomotives, periodical statistics of repairs are kept, such repairs being classed by categories.

Goods stock. Maintenance. — The costs are worked out per axle-mile of wagon, and statistics of repairs are kept by categories or types of wagons when these types are differentiated in any marked fashion.

Traction expenses. — The traction expenses are worked out per locomotive-mile and car axle-mile and the statistics of such expenses are kept in a very detailed manner and, taken as a whole in confor-

mity with the indications given by the reporter.

Traffic expenses.

Traffic expenses. — The traffic expenses are divided into train expenses and station expenses.

The expenses of the first category are worked out per train-mile of the fast, ordinary and slow trains, whilst the station expenses are related to the length of the line, an obviously very summary method.

As regards the costs of the handling of luggage and goods by the stations, they are worked out per pood of goods dealt with.

Very detailed statistics give, for the work of each station and for the financial year, the number of trains, carriages and wagons received, dispatched, and exchanged, with neighbouring lines; the number of poods loaded and unloaded; the number of passenger tickets issued; the number of luggage-tickets and waybills for parcels and goods; the number of telegraphic messages exchanged; the receipts cashed; the hours and mileages of shunting locomotives and their relation to the wagons and poods received and forwarded.

General and other charges.

General and other charges. — The principles governing the general charges upon the Russian systems are in every respect similar to those indicated by the reporter. We have therefore no observations to offer on this subject.

Stores department.

g) **Statistics relating to indirect and subsidiary services. — Indirect services.** — The service of furnishing supplies for the Russian railways is strictly centralized in a special department or service (that of the stores), even in the case where certain issues of stores are made directly by the consuming services (notably by that of the way and works). As all the documents are centralized in the stores service, the latter prepares every month an inventory in the form given in annex IX to our report on the question of accounts. It is compared with the figures of two successive years, and particulars are given of the surplus stock of each category of stores, their receipt and issue during the financial year, the deliveries made to each consuming service : the whole according to category and value (roubles), care being taken to mention the proportion per cent relatively to the material in stock. The warehousing expenses are charged to the consuming services.

Work-shops.

The workshops of the Russian railways are placed under the direction of the chief engineer of the locomotive department, and the organization and working alike correspond exactly to that of the British colonial system. Several statistical tables relate to this service. There is, first of all, table VII, drawn up by the commission of 1884, the data for which are furnished by each workshop separately. Then comes a very detailled enumeration of all the works executed during the financial year, with information as to the object, quantity, nature and costs of annotation, labour and materials (including also the spares, etc.).

It goes without saying that the whole of these details do not appear in the report and accounts for the financial year, although they are to be found in the

workshop books, where they are recorded in the minutest possible fashion.

Subsidiary services. — The subsidiary services are practically identical with those enumerated by the reporter, and the statistics are not of any particular interest. All the operations relating to lifts, town offices, etc., are a part of the subsidiary services.

aff, social onditions.

h) **Other miscellaneous statistics.** — Independently of tables showing the number and remuneration, as well as the average pay of the staff in the different services, statistics of the social conditions of the staff are kept relating specially (and exclusively) to pension, savings-bank and relief funds, etc. Particulars of rather exceptional interest, in relation to sex, age, civil condition, length of service, causes of changes, average renumeration, etc., are recorded.

Other social statistics.

The Russian railways are bound to furnish reports on all accidents, even those of the slightest importance. A summary of such reports appears in tables X and XI of the statistical record of the ministry of ways of communication. These statistics respond exactly to the wishes expressed by the reporter.

THIRD PART.

Uniform classification of working expenses.

The Russian railway systems (State and companies alike) make use of a form of classification of expenses imposed upon them by the government in accordance with a scheme elaborated by the commission of 1884. As we have inserted this classification in annex III to our report on Russian railway accounts, we limit ourselves to reproducing the principal sections, in the order of classification set forth in the comparative table given by Sir Thomas Rees Price (1).

(1) See *Bulletin of the Railway Congress*, number of December, 1909, p. 1604.

Section III. — *Maintenance of way and works; supervision, maintenance and repairs.*

This section contains the three following divisions :

Division 1. — Costs of central service of way and works.

Division 2. — Supervision of way and of constructive works, etc.; their maintenance and repair.

Division 3. — Supervision of buildings, their maintenance and repair.

This section corresponds exactly to the service of way of the French system.

SECTION V. — *Traction expenses : maintenance and repair of rolling stock.*

This section contains seven divisions, *viz.* :

Division 1. — Costs of central traction service.

Division 2. — Traction.

Division 3. — Maintenance of carriages and wagons.

Division 4. — Maintenance of central workshops attached to locomotive sheds for the repair of rolling stock.

Division 5. — Renewal and repair of locomotives and tenders.

Division 6. — Renewal and repair of carriages and wagons.

Division 7. — Hire of rolling stock.

This section corresponds exactly to the service of equipment (locomotives and rolling stock) and traction (*i. e.*, running expenses) of the French system.

SECTION IV. — *Service of traffic and telegraphs.*

This section contains four divisions, *viz.* :

Division 1. — Costs of central service of traffic and telegraphs.

Division 2. — Service of stations and yards.

Division 3. — Service of trains.

Division 4. — Service of telegraphs and telephones.

This section corresponds fairly closely with the traffic service of the French system, except as regards the commercial service of receipts which, in Russia, are included in the general expenses (section I).

SECTION I. — *Central administration (or board of administration). Commercial service, service of receipts and general expenses.*

This section comprises three divisions, *viz.* :

Division 1. — Costs of central administration and commercial service.

Division 2. — Costs of service of receipts.

Division 3. — General expenses.

SECTION II. — *Management of each system; medical service and stores.*

This section contains four divisions, *viz.* :

Division 1. — Costs of manager, his assistants and office of management.

Division 2. — Costs of medical service.

Division 3. — Costs of stores service.

Division 4. — General costs of the management services of each system.

Sections I and II correspond fairly closely with the general administration of the French system.

An analysis of this classification shows that it includes, at the same time, the whole of the particulars furnished by the American classification, *viz.* :

1. The maintenance of the track and its appurtenances and of the buildings utilized in connection with its operation (section III).

2. The maintenance of the locomotives and rolling stock used for the conveyance of traffic (section V, divisions 4, 5 and 6).

3. Expenditure incurred in obtaining traffic and in affording information as to the facilities given by lines for the conveyance of traffic (section I, division 1, commercial service).

4. Expenditure directly or indirectly connected with the actual conveyance of traffic : such as cost of operation of trains and stations (section IV, divisions 2 and 3; section V, division 2).

5. General expenses (sections I and II).

We are of opinion that this classification would readily lend itself to the plan proposed by Sir Thomas Rees Price, *viz.* :

1. Maintenance of way, works and structures.
2. Maintenance of equipment.
3. Transportation and traffic expenses :
   a) Running expenses and supplies (locomotives and vehicles).
   b) Station and other traffic staff.
   c) Cost of obtaining traffic, etc.
4. General charges.

We are equally disposed to believe that a uniform method of classification would be applicable to all the railways, by the adoption for lines of lesser importance of the classification by main heads or sections, and for the others that by subdivisions, sub-heads, etc. We may further remark that the classification of expenses imposed in Russia upon all railways (to the total of 323 index numbers), without account being taken of their relative commercial importance, appears excessive and will probably be reduced by at least one-half.

Treatment of expenditure on indirect services.

We have no objection to raise, as far as the subsidiary services are concerned, after what we have said as to the position they occupy in our classification.

Other matters affecting working expenditure.

a) *Real estate.*

Any profit (or loss) on *real estate* account is carried to the revenue account (section III : receipts pertaining to financial and supplementary operations or to expense account; section VIII : expenses pertaining to financial of supplementary operations).

b) *Depreciation of capital assets.*

The commission of 1884 (p. 195, line 3 of our report on the question of accounts) investigated the question of the liquidation of the costs of renewal of rails, plant and rolling stock in the proportion of the mileages effected during the financial year, as well as the method of charging the corresponding expenses.

Although provisions in conformity with its views were introduced in the form of special regulations, they did not receive the sanction of the government, the latter fearing that the effect of the allowance for depreciation would be prejudicial to the guarantee of interest of the State.

c) *Capital expenditure and expenditure for betterment.*

The original establishment expenses are carried to the balance-sheet of the under-

taking, whilst the expenses for betterment are carried to a special account, the classification of which we have given in annex V to our report on accounts. It is of the highest importance that such expenses (except those of a very minor character) should be kept strictly separate from the working expenses.

FOURTH PART.

Conclusions.

We fully share the opinion of the honourable reporter with regard to the classification of the permanent statistics (having special reference to the returns for each financial year) and of the temporary tables or statements, as well as the necessity for bringing about some sort of uniformity in the methods of railway accounting, for effecting, at any rate, *the standardizing of the principal statistical returns and the establishment of a recognized standard classification of statistical data.*

We are entirely in accord with the views of the reporter as to the incalculable advantages which should accrue, not only to the railways of the world but also to the governments, the press and the public at large, from the adoption of a standard classification of budget (and balance-sheet).

Although the labours of the International congress on statistics convoked at The Hague in 1881, have remained in suspense since the publication of data concerning the system of European railways for 1882, we are glad to think that this question, taken up again *after postponement for nearly thirty years*, will be settled in a satisfactory manner. It will suffice for us to recall, in connection with this prognostic, the ever-celebrated saying of Napoleon I: "*If it is possible, it is done; if impossible, it shall be done.*"

FIFTH PART.

Annexes.

I. — General statistics of the ministry of ways of communication of Russia (tables I, II, III, IV, V, VI, VII, VIII, IX, X, XI).

II. — Statistical annexes to the returns for each financial year, introduced by the commission of 1884 (tables I, II, III, IV, V, VI, VII, VIII, IX, X).

III. — Scheme of periodical statistical statements, of a temporary character, now in preparation.

ANNEX I

General statistics of the ministry of ways of communication of Russia

(Tables I to XI.)

Table I-A. — **Financial position of railways operated by the State at the end of financial year.**

1	2	3	4	5	6	7	8	9	10	11	12	13	14
Index number.	DESIGNATION OF LINE.	Length of lines at end of financial year.	Date of redemption of lines (year, month and day).	Original capital, and subsequent additions.				Other expenditure since date of opening				Total first-establishment expenses.	
				Bonds converted by the government (consols).				upon the State Treasury.			upon the working receipts and other funds.	Total	By verst of length.
				Nominal amount.	Annual costs of guarantee of interest and amortization.			Nominal sum.	Interest and amortization expenses for the financial year.			Roubles (credit).	
					For the whole capital indicated in column 5, for the year.		Total amount for the financial year.						
					Total.	Per cent.			Total.	Per cent.			
		Versts.		Roubles.		Per cent.	Roubles.	Roubles.		Per cent.	Roubles.	Roubles.	

Table I-B. — **Financial position of railways operated by the companies at the end of financial year.**

1	2	3	4	5	6	7	8	9	10	11	12
Index number.	DESIGNATION OF LINE.	Length of lines at close of financial year.	Concession.			Construction capital (original and supplementary).					
						In stock					
			Number of years. (duration).	Date of commencement and end of concession (year, month and day).	Date of right of redemption by the government (year, month and day).	guaranteed by the government.				Without guarantee (nominal sum).	Total in stock (nominal sum).
						Total sum.	Annual expenses of government for guarantee				
							on the whole capital indicated in column 7 for the year		Total amount for the financial year.		
							Total.	Per cent.			
		Versts.				Roubles		Per cent.	Roubles.		

Table I-B (continued). — **Financial position of railways operated by the companies at the end of financial year.**

Index number.	DESIGNATION OF LINE.	13	14	15	16	17	18	19	20	21	22	23	24
		Construction capital (original and supplementary).											
		Bonds.											
		Converted by the companies								Converted by the government (consols).			
		without guarantee of interest.				with guarantee of interest.							
		Nominal total.	Annual expenditure on the whole capital indicated in column 13 for the year.		Sum for the financial year.	On nominal total.	Annual expenditure of government for guarantee on the whole capital indicated in column 17 for the year.		Sum total for the financial year.	Nominal total.	Annual expenditure for interest and amortization by government on the whole capital indicated in column 21 for the year		Sum total for the financial year.
			Total.	Per cent.			Total.	Per cent.			Total.	Per cent.	
		Roubles.		Per cent.	Roubles.		Roubles.	Per cent.	Roubles.			Per cent.	Roubles

Table I-B (continued). — **Financial position of railways operated by the companies at the end of financial year.**

Index number.	DESIGNATION OF LINE.	25	26	27	28	29	30	31
		Original and supplementary capital		Annual expenditure for stocks and bonds guaranteed. Interest and amortization.		Other establishment expenses since origin of line		
		in bonds.	Total capital sums for construction (nominal amount).	On the whole capital indicated in column 26 for the year.	Total amount for the financial year.	Government loans on the bonds.		On working receipts and special funds
		Total in bonds (nominal amount).				Nominal amount.	Interest and liquidation for the year.	
		Roubles.				Roubles.	Per cent.	Roubles.

Table I-B (continued). — **Financial position of railways operated by the companies at the end of financial year.**

1	2	32	33	34	35	36	37	38
Index number.	DESIGNATION OF LINE.	Total amount of construction capital.			Auxiliary capital sums at end of financial year.			
		Nominal amount	Total.	Per verst of length.	Floating capital		Reserve funds and renewals fund.	Other special funds.
			Paper roubles.		to account of construction capital.	to account of other resources.		
		Roubles.			Roubles.			

Table II. — **Length, construction of track, and number of stations at end of financial year.**

Index number.	DESIGNATION OF LINE AND OF SECTIONS WORKED	Date of opening.		1	2	3	4	5	6	7	8	9	10	11	12	13	14
				Length of lines and branches constructed					Analysis of length according to conditions								
				Lines.		Branch lines.		Total.		Including double tracks.	Straight lines.		Curves.								Minimum radius in sagenes.
													Total.		Radius of more than 300 sagenes.		Radius of 300 sagenes or less.			
		Year.	Month.	Versts.	Sagenes.	Versts.	Sagenes.	Versts.	Sagenes.	Versts.	Sagenes.	Per cent.	Versts.	Sagenes.	Per cent.	Versts.	Sagenes.	Per cent.	Versts.	Sagenes.	Per cent.	

Table II (continued). — **Length, construction of track, and number of stations at end of financial year.**

Index number.	DESIGNATION OF LINE AND OF SECTIONS WORKED.	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
		Analysis of length of lines according to condition of profile.													Number of stations and other installations.			
		Horizontal lines.			Up and down gradients.										Home.			Foreign.
					Total up and down gradients.			From 1 to 5 per mil.			From 6 to 10 per mil.			From 11 to 15 per mil.			More than 15 per mil.			Up and down gradients, steepest, per mil.				
		Versts.	Sagenes.	Per cent.	Versts.	Sagenes.	Per cent.	Versts.	Sagenes.	Per cent.	Versts.	Sagenes.	Per cent.	Versts.	Sagenes.	Per cent.	Versts.	Sagenes.	Per cent.		Passenger	Others.	Total.	Passenger.

Table II (continued). — **Length, construction of track, and number of stations at end of financial year.**

Index number.	DESIGNATION OF LINE AND OF SECTIONS WORKED.	32	33	34		35		36		37	38	39		40		41		42	43		44	
		Length of line (rails) constructed.								Analysis of length of line (rails) constructed											Length of private lines.	
				Lines and branch lines.		Service branch lines.		Sidings, etc.	Total.	according to nature of rails;				according to nature of supports:								
										of steel	of iron.	mixed.		on wood					lines entirely metallic.			
														Total.		including impregnated.		Per cent.				
		Versts.	Sagenes.	Per cent.	Versts.	Sagenes.	Versts.	Sagenes.	Versts.	Sagenes.	Versts.	Sagenes.	Versts.	Sagenes.	Versts.	Sagenes.	Versts.	Sagenes.		Versts.	Sagenes.	Versts.	Sagenes.

Table III-A. — **Number of locomotives in service on railways at end of financial year.**

Index number.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
	DESIGNATION OF LINE.	Length of construction at end of financial year.	Number of locomotives.		Analysis of locomotives according to destination.					Number of tenders				Number of axles of locomotives			Analysis of locomotives according to nature of fuel.		
		Versts.	Total.	Including compound system.	Passenger and composite locomotives.	Goods			Shunting locomotives.	Total.	two axles.	three axles.	four axles	driving.	driving and carrying.	tenders.	Coal.	Naphta.	Firewood.
						three axles	four axles.	others.											
						Per number of driving axles.													

Table III-A (continued). — **Number of locomotives in service on railways at end of financial year.**

Index number.	1	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36
	DESIGNATION OF LINE.	Number of locomotives with continuous brake.					Including number of axles with brakes.		Number of locomotives fitted with brakes worked by driver.	Weight (without water or fuel, but with axles and wheels).						Initial costs of locomotives with tenders		
		System			Others.	Total.	Locomotives, driving.	Tenders.		Locomotives			Tenders			total.	per unit of locomotive with tender.	per ton.
		Westinghouse.	Hardy.	Weiger.						per unit.	total.	per axle.	per unit.	total.	per axle.			
										Metric tons.						Roubles, in thousands		Roubles.

Table III-A (continued). — **Number of locomotives in service on railways at end of financial year.**

1	2	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80	81	82
Index number	DESIGNATION OF LINE	Analysis of number of locomotives at end of year according to priority of service.																																													Motor cars.
		1857	1858	1859	1860	1861	1862	1863	1864	1865	1866	1867	1868	1869	1870	1871	1872	1873	1874	1875	1876	1877	1878	1879	1880	1881	1882	1883	1884	1885	1886	1887	1888	1889	1890	1891	1892	1893	1894	1895	1896	1897	1898	1899	1900	1901	
		Number of locomotives.																																													

Table III-B. — **Number of passenger carriages, mail and luggage vans at or about end of year, with indication of their construction and cost.**

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
Index number.	DESIGNATION OF LINE.	Length in operation at end of year.	Coaching vehicles.																				
			Stock proper (belonging to the government, private persons, etc.) :				Including :		Including :			Distribution of coaching vehicles at or about end of year :											
			at or about beginning of year.	during the year :		at end of year.	belonging to the government.	belonging to private persons.	with two axles.	with three axles.	with four axles.	forming part of imperial trains.	saloons and carriages of inspection and management staff.	Vehicles of different classes, including sleeping-cars.							Prisoners.	Hospital.
				entry.	exit.									1st class.	1st and 2nd class.	2nd class.	2nd and 3rd class.	3rd class.	1st, 2nd and 3rd class.	4th class.	Total.		
		Versts	Number of vehicles.																				

Table III-B (continued). — **Number of passenger carriages, mail and luggage vans at or about end of year, with indication of their construction and cost.**

1	2	25	26	27	28	29	30	31	32	33	34	34a	35	36	37	38	39	40	41	42	43	44	45	46
		Coaching vehicles.																						
Index number.	DESIGNATION OF LINE.	Number of seats and number of axles in whole of vehicle.										Average number of seats per axle of coaching vehicle.	Number of seats in vehicles for		Number of axles:				Tare axles and wheels:			Cost of the stock:		
		1st class.		2nd class.		3rd class.		4th class.		Total.			prisoners.	hospital.	Total.	average:			Total.	average		Total.	average	
		Number of seats.	Number of axles.	Number of seats.	Number of axles.	Number of seats.	Number of axles.	Number of seats.	Number of axles.	Number of seats.	Number of axles.					per vehicle.	per verst operated.	per 1,000,000 axle-versts of passenger vehicles.		per vehicle.	per axle.		per vehicle	per axle.
																			Poods.			Roubles (paper).		

Table III-B (continued). — **Number of passenger carriages, mail and luggage vans at or about end of year, with indication of their construction and cost.**

1	2	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61	62	63	64	65	66
		Mail vans.											Luggage vans.								
Index number.	DESIGNATION OF LINE.	Number at end of year.	Including vans belonging to the postal authorities.	Number of axles:			Tare including axles and wheels:			Cost of inventory:			Home stock belonging to the government, to private persons, etc.:				Including:		Transport capacity.		
				Total.	average:		Total.	average:		Total.	average:		at commencement of year.	during the year:		at end of year.	vans belonging to the government.	vans belonging to private persons.	Total.	Average:	
					per van.	per verst operated.		per van.	per axle.		per van.	per axle.		entry.	exit.					per van.	per axle.
							Poods.			Roubles (paper).			Number of vans.						Poods.		

Table III-B (continued). — **Number of passenger carriages, mail and luggage vans at or about end of year, with indication of their construction and cost.**

1	2	67	68	69	70	71	72	73	74	75	76	77	78	79	80	81	82	83	84	85	86	87
		Luggage vans										Auxiliary vans		Total of coaching vehicles.				Total number of vehicles				
		Number of axles.				Tare, including axles and wheels.			Cost of inventory.													
Index number.	DESIGNATION OF LINE.	Total.	Average: per van.	Average: per verst operated.	Average: per 1,000,000 axles-versts run.	Total.	Average: per van.	Average: per axle.	Total.	Average: per van.	Average: per axle.	at or about end of year.	number of axles.	Total.	Average. Total.	Average: per vehicle.	Average: per verst operated.	fitted with continuous brake. Number of vehicles.	fitted with continuous brake. Number of axles with brakes.	fitted with hand-brake. Number of vehicles.	fitted with hand-brake. Number of axles with brakes.	fitted with apparatus for regulation of speed.
						Poods.			Roubles (paper).													

Table III-C. — **Number of goods wagons at end of financial year, with particulars of design and cost.**

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26
			Goods wagons.																						
			Home stock including that belonging to the government, to private persons, etc.:				Including:		Of the total number of wagons at end of year.														Transport capacity.		
									Normal type:								Special type:								
Index number.	DESIGNATION OF LINE.	Length operated.	at commencement of year.	during the year. Entry.	during the year. Exit.	at end of financial period.	belonging to the government.	belonging to private persons.	covered. Number of wagons.	covered. Number of axles.	wagons with sides. Number of wagons.	wagons with sides. Number of axles.	open, flat. Number of wagons.	open, flat. Number of axles.	total. Number of wagons.	total. Number of axles.	Passenger trucks.	Trucks. For building-timber.	For powder and inflammable and explosive matter.	For cattle and horses	For other goods.	Total.	Average: per wagon.	Average: per axle.
			Number of wagons.														Number of wagons.						Poods.		

Table III-C (continued). — **Number of goods wagons at end of financial year, with particulars of design and cost.**

1	2	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46
Index number.	DESIGNATION OF LINE.	Goods wagons.										Auxiliary wagons		Total		Of the total number of wagons					
			Number of axles.			Tare, including axles and wheels.			Cost of inventory.							fitted with continuous brake.		fitted with pipe for continuous brake.	fitted with hand-brake.		fitted with apparatus for the regulation of speed.
		Total.	Average per wagon.	Average per verst operated.	Average per 1,000,000 axle-versts.	Total.	Average per wagon.	Average per axle.	Total.	Average per wagon.	Average per axle.	at end of year. number of axles.		number of wagons.	number of axles.	Number of wagons.	Number of axles with brake.	Wagons.	Number of wagons.	Number of axles with brake.	Wagons.
						Poods.			Roubles (paper).												

Table IV. — **Effective force and cost of maintenance of railway staff during the financial year.**

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
Index number.	DESIGNATION OF LINE.	Length of lines operated at or about end of year.	Administration of system.															
			Central administration.						Local administration.						Total.			
			Employees and workmen.				Day labourers.		Employees and workmen.				Day labourers.		Employees and workmen.			
			Permanent.		Temporary.				Permanent.		Temporary.				Permanent.		Temporary.	
			Number.	Expenditure.	Number.	Expenditure.	Number.	Expenditure.	Number.	Expenditure.	Number.	Expenditure.	Number.	Expenditure.	Number.	Expenditure.	Number.	Expenditure.

Table IV (continued). — **Effective force and cost of maintenance of railway staff during financial year.**

1	2	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37
Index number.	DESIGNATION OF LINE.	Administration of system.						Service of way and works.										Locomotive and rolling stock service.	
		Day labourers.		Total.				Employees and workmen.				Day labourers.		Total.				Employees and workmen.	
				Number.		Expenditure.		Permanent.		Temporary.								Permanent.	
		Number.	Expenditure.	Total.	Per verst.	Total.	Per verst.	Number	Expenditure.	Number.	Expenditure.	Number.	Expenditure.	Number.	Per 100,000 train-versts.	Expenditure.	Per 100,000 train-versts.	Number.	Expenditure.

Table IV (continued). — **Effective force and cost of maintenance of railway staff during financial year.**

1	2	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55
Index number.	DESIGNATION OF LINE.	Locomotive and rolling stock service.								Traffic service.									
										Total.									
		Employees and workmen.		Day labourers.		Total.				Employees and workmen.				Day labourers.		Total			
		Temporary.								Permanent.		Temporary.							
		Number.	Expenditure.	Number	Expenditure.	Number.	Per 100,000 train-versts.	Expenditure.	Per 100,000 train-versts.	Number.	Expenditure.	Number.	Expenditure.	Number.	Expenditure.	Number.	Per 100,000 train-versts.	Expenditure.	Per 100,000 train-versts.

Table IV (continued). — **Effective force and cost of maintenance of railway staff during financial year.**

1	2	56	57	58	59	60	61	62	63	64	65	66	67	68	69	70	71	72	73
Index number.	DESIGNATION OF LINE.	Working service including telegraphic service.										Total of employees and workmen.							
		Employees and workmen.				Day labourers.		Total.				Permanent.				Temporary.			
		Permanent.		Temporary.								Number.		Expenditure.		Number.		Expenditure.	
		Number.	Expenditure.	Number.	Expenditure.	Number.	Expenditure.	Number.	Per 100,000 train-versts.	Expenditure.	Per 100,000 train-versts.	Total.	Per verst.	Total.	Per verst.	Total.	Per verst.	Total.	Per verst.

Table IV (continued). — **Effective force and cost of maintenance of railway staff during financial year.**

1	2	74	75	76	77	78	79	80	81	82	83	84	85	86	87
Index number.	DESIGNATION OF LINE.	Total employees and workmen.								Analysis of total number of employees :					
		Day labourers.				Total.				engine drivers.	firemen.	guards and conductors	pointsmen.	foremen of gangs.	line-keepers.
		Number.		Expenditure.		Number.		Expenditure.							
		Total.	Per verst.	Total.	Per verst.	Total.	Per verst.	Total.	Per verst.	Number.	Number.	Number.	Number.	Number.	Number.

Table V. — **Mileage of rolling stock during financial year.**

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
Index number.	DESIGNATION OF LINE.	Length of road in operation at end of year.	Mileage of home and foreign stock.													
			Home mileage.										Mileage of locomotives alone.			
			Commercial trains.				Military trains:		Service trains:		Total.	Including double-heading.	Light.	Reserve.	Shunting.	Total.
			Fast and ordinary service:		Goods service:											
			Total.	including double-heading.	Total.	including double-heading.	Total.	including double-heading.	Total.	including double-heading.						
			Locomotive-verst.													

Table V (continued). — **Mileage of rolling stock during financial year.**

1	2	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33
Index number.	DESIGNATION OF LINE.	Mileage of home and foreign locomotives.									Mileage of coaching vehicles classed and special.						
		Total mileage with and without trains.	Mileage of trains with multiple crew.	Ratio of mileage without trains to total mileage.	Of the total mileage effected:						Home and foreign stock on home system:		Total mileage of vehicles classed.				Mileage of mail vans on home system.
					firewood.		anthracite and coal.		naphte and residus.		Total.	per verst of line in operation.	1st class.	2nd class.	3rd class.	4th class	
		Locomotive-verst.			Locomotive-verst.	Per cent.	Locomotive-verst.	Per cent.	Locomotive-verst.	Per cent.	Thousand axle-versts.	Thousand axles.	Thousand axle-versts.				

Table V (continued). — **Mileage of rolling stock during financial year.**

1	2	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49
Index number.	DESIGNATION OF LINE.	Mileage of luggage vans.		Mileage of goods wagons.						Mileage of home and foreign wagons on home system with the exception of auxiliary wagons :		Analysis of total mileage of all the wagons mentioned in column 42 :				Mileage of goods and tare on home system :	
		Home and foreign stock on home system :		Home and foreign stock on home system :			Mileage indicated in columns 36-38 in relation to loaded wagons :		Rate per cent of column 39 to column 36.	Total.	average per verst operated.	goods trains		military trains.	service trains.	coaching vehicles, with the exception of prisoners and their escort	
		Total.	per verst of length of track.	Total.	per verst of length of track.	including cisterns.	Total.	including cisterns.				quick and ordinary service.	slow freight.			1st class.	2nd class.
		Thousand axle-versts.	Thousand axles.	Thousand axle-versts.	Thousand axles.	Thousand axle-versts.				Thousand axle versts.	Thousand axles	Thousand axle-versts.				Thousand passenger-versts.	

Table V (continued). — **Mileage of rolling stock during financial year.**

1	2	50	51	52	53	54	55	56	57	58	59	60	61	62	63	64	65
Index number.	DESIGNATION OF LINE.	Mileage of goods and tare on home system :															
		Mileage of goods :						Mileage of tare :								average.	
		passengers, excepting prisoners and their escort		total of passengers, with their hand-luggage, 5 poods.	luggage.	other goods of all kinds.	Total.	locomotives with tenders loaded with water and fuel.	coaching vehicles.	mail vans.	luggage vans.	goods wagons.	auxiliary wagons.	Total.	General total (gross weight).	per verst of line operated.	per locomotive with train.
		3rd class.	4th class.														
		Thousand passenger-versts.		Thousand pood-versts.												Thousand poods.	

Table V (continued). — **Mileage of rolling stock during financial year.**

1	2	66	67	68	69	70	71	72	73	74	75	76	77	78	79
Index number	DESIGNATION OF LINE.	Average axle load on home system :													
		coaching vehicle :								luggage van :		goods wagon :			
												loaded and empty :		loaded only :	
		1st class.	percentage of total number of 1st class seats.	2nd class.	percentage of total number of 2nd class seats.	3rd class.	percentage of total number of 3rd class seats.	4th class.	percentage of total number of 4th class seats.	Total.	percentage of transport capacity.	Total.	percentage of transport capacity.	Total.	percentage of transport capacity.
		Passengers.	Per cent.	Passengers.	Per cent.	Passengers.	Per cent.	Passengers.	Per cent.	Poods.	Per cent.	Poods.	Per cent.	Poods.	Per cent.

Annex to Table V. — **Quantity and cost of fuel for firing locomotives.**

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
Index number.	DESIGNATION OF LINE.	Length of track operated at end of year.	Firewood :				Mineral fuel :											
			for firing of locomotives.	to effect the kindling of anthracite and coal.	Total.		peat.		anthracite.		coal.		briquettes.		coke.		Total.	
		Versts.	Cubic sagenes.	Cubic sagenes.	Number of cubic sagenes.	Cost in roubles.	Number of poods.	Cost in roubles.	Number of poods.	Cost in roubles.	Number of poods.	Cost in roubles.	Number of poods.	Cost in roubles.	Number of poods.	Cost in roubles.	Number of poods.	Cost in roubles.

Annex to table V (continued). — **Quantity and cost of fuel for firing locomotives.**

1	2	20	21	22	23	24	25	26	27	28	29	30	31
Index number.	DESIGNATION OF LINE.	Mineral fuel naphta and residues.		Total cost in roubles	Average expenditure for 1,000 locomotive-versts.								
					On firewood.		On mineral fuel :					On naphta and residues.	
					On firewood.		anthracite and coal.		kindling wood.		Total in roubles.	Naphta.	
		Number of poods.	Cost in roubles.		Cubic sagenes.	Roubles.	Poods.	Roubles	Cubic sagenes.	Roubles.		Poods.	Roubles.

Table VI. — **Number, mileage and composition of trains during financial year.**

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
Index number.	DESIGNATION OF LINE.	Length of line in operation at end of year.	Commercial traffic.																	
			Fast and ordinary traffic.										Slow-freight service.							
			Special and imperial trains.		Express and mail trains.		Postal and passenger trains.		Mixed trains.		Total.		Goods trains		Junction trains.		Service trains.		Total.	
			Number.	Mileage.	Number	Mileage.	Number.	Mileage.	Number.	Mileage.	Number.	Mileage.	Number.	Mileage.	Number.	Mileage.	Number.	Mileage.	Number.	Mileage.

Table VI (continued). — **Number, mileage and composition of trains during financial year.**

1	2	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41
Index number.	DESIGNATION OF LINE.	Military trains :								Service trains :										General total.	
		men.		hospital.		effects.		Total.		staff.		materials.		ballast.		earth.		Total.			
		Number.	Mileage.	Number.	Mileage	Number.	Mileage.	Number.	Mileage.	Number.	Mileage.	Number.	Mileage.	Number.	Mileage.	Number.	Mileage.	Number.	Mileage.	Number.	Mileage.

Table VI (continued). — **Number, mileage and composition of trains during financial year.**

1	2	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61	62
Index number.	DESIGNATION OF LINE.	Analysis of mileage (per cent) :				Average composition of trains :												Average number of mileages of trains (train-versts) per verst of length of track and per day :				
		commercial traffic :		military traffic.	service traffic.	commercial traffic :				military traffic.		service traffic :				Total.		commercial traffic :		military traffic.	service traffic.	total of trains.
						fast and ordinary trains.		slow-freight service.				staff.		other transports.								
		fast and ordinary service.	slow-freight service.			Wagons.	Axles.	Wagons.	Axles.	Wagons.	Axles.	Wagons.	Axles.	Wagons.	Axles.	Wagons.	Axles.	fast and ordinary service.	slow-freight service.			

Table VII. — **Transports and gross receipts of railways during financial year.**

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
Index number.	DESIGNATION OF LINE.	Length of track in operation at end of year.	Passenger traffic and gross receipts.																	
			Passengers at ordinary fares :																	
			1st class passengers.									2nd class passengers.								
			Total.			Including :						Total.			Including :					
						children.			passes.						children.			passes.		
			Number.	Mileage.	Receipts.	Number.	Mileage.	Receipts.	Number.	Mileage.	Receipts.	Number.	Mileage.	Receipts.	Number.	Mileage.	Receipts.	Number.	Mileage.	Receipts.

Table VII (continued). — **Transports and gross receipts of railways during financial year.**

1	2	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39
Index number.	DESIGNATION OF LINE.	Passenger traffic and gross receipts.																	
		Passengers at ordinary fares :																	
		3rd class passengers.									workmen.			emigrants.			Total.		
		Total.			Including :														
					children.			passes.											
		Number.	Mileage.	Receipts.	Number.	Mileage.	Receipts.	Number.	Mileage.	Receipts.	Number.	Mileage.	Receipts.	Number.	Mileage.	Receipts.	Number.	Mileage	Receipts.

Table VII (continued). — **Transports and gross receipts of railways during financial year.**

1	2	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58
Index number.	DESIGNATION OF LINE.	Passenger traffic and gross receipts.																		
		Military tariff.												Prisonners and escort.			Free tickets.			
		1st class.			2nd class.			3rd class.			Total.						1st class.		2nd class.	
		Number.	Mileage.	Receipts.	Number.	Mileage.	Receipts.	Number.	Mileage.	Receipts.	Number.	Mileage.	Receipts.	Number.	Mileage.	Receipts.	Number.	Mileage.	Number.	Mileage.

Table VII (continued). — **Transports and gross receipts of railways during financial year.**

1	2	59	60	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75
Index number.	DESIGNATION OF LINE.	Passenger traffic and gross receipts.																
		Free tickets.				Cattle drovers :						Total.			Average.			
		3rd class.		Total.		quick-freight trains.			slow-freight trains.						Number of passenger-verst per verst of length of track.	Average mileage of a passenger.	Average number of passengers per axle of passenger car.	Ratio of occupied to vacant seats.
		Number.	Mileage.	Number.	Mileage.	Number.	Mileage.	Receipts.	Number.	Mileage.	Receipts.	Number.	Mileage.	Receipts.				

Table VII (continued). — **Transports and gross receipts of railway during financial year.**

1	2	76	77	78	79	80	81	82	83	84	85	86	87	88	89	90	91
Index number.	DESIGNATION OF LINE.	Passenger traffic and gross receipts.				Goods traffic and gross receipts.											
		Averages.				Luggage at ordinary tariff in passenger and mixed trains.			Dogs conveyed in passenger and mixed trains.			Parcels and goods by fast train, with the exception of military effects and postal packets.			Goods by fast train, with the exception of military transports.		
		Average for passenger traffic :			Ratio of passenger transport receipts to gross receipts.												
		per versl.	per passenger.	per passenger-versl.		Number.	Mileage.	Receipts.	Number.	Mileage.	Receipts.	Number.	Mileage.	Receipts.	Number.	Mileage.	Receipts.

Table VII (continued). — **Transports and gross receipts during financial year.**

1	2	92	93	94	95	96	97	98	99	100	101	102	103	104	105	106
Index number.	DESIGNATION OF LINE.	Goods traffic and gross receipts.														
		Slow-freight goods, excepting military goods.			Cattle by slow-freight trains.			Horses (excepting military) :								
								per passenger and mixed trains.			goods trains					
											quick freight.			slow freight.		
		Number.	Mileage.	Receipts.	Number.	Mileage.	Receipts.	Number.	Mileage.	Receipts.	Number.	Mileage.	Receipts.	Number.	Mileage.	Receipts.

Table VII (continued). — **Transports and gross receipts of railways during financial year.**

1	2	107	108	109	110	111	112	113	114	115	116	117	118	119	120	121	122	123	124
Index number.	DESIGNATION OF LINE.	Goods traffic and gross receipts.																	
		Other animals :									Transports by the piece (military excepted) :								
		by passenger and mixed trains.			by goods trains :						by passenger and mixed trains.			by goods trains :					
					quick freight.			slow freight.						quick freight.			slow freight.		
		Number.	Mileage.	Receipts.	Number.	Mileage.	Receipts.	Number.	Mileage.	Receipts	Number.	Mileage.	Receipts.	Number.	Mileage.	Receipts.	Number.	Mileage.	Receipts.

Table VII (continued). — **Transports and gross receipts of railways during financial year.**

1	2	125	126	127	128	129	130	131	132	133	134	135	136	137	138	139	140	141	142
Index number.	DESIGNATION. OF LINE.	Goods traffic and gross receipts.																	
		Military traffic :									Military horses :								
		by passenger : and mixed trains.			by goods trains :						by passenger : and mixed trains.			by goods trains :					
					quick freight.			slow freight.						quick freight.			slow freight.		
		Number.	Mileage.	Receipts.	Number.	Mileage.	Receipts.	Number.	Mileage.	Receipts.	Number.	Mileage.	Receipts.	Number.	Mileage.	Receipts.	Number.	Mileage.	Receipts.

Table VII (continued). — **Transports and gross receipts of railways during financial year.**

Index number.	DESIGNATION OF LINE.	143	144	145	146	147	148	149	150	151	152	153	154	155	156	157	158	159
		Goods traffic and gross receipts.																
		Military traffic (" smalls "):									Service traffic.			Total.			Whereof animals and transport " in smalls ".	
		by passenger and mixed trains.			by goods trains													
					quick freight.			slow freight.										
		Number.	Mileage.	Receipts.	Number.	Mileage.	Receipts.	Number.	Mileage.	Receipts.	Number.	Mileage.	Receipts.	Number.	Mileage.	Receipts.	Number.	Mileage.

Table VII (continued). — **Transports and gross receipts of railways during financial year.**

Index number.	DESIGNATION OF LINE.	160	161	162	163	164	165	166	167	168	169	170	171	172	173	174
		Goods traffic and gross receipts:								Supplementary receipts:						
		averages.								for the transport:			other provisional receipts:			
		Average number of pood-versts per verst of length of track.	Average mileage of a pood of goods.	Average number of poods of goods per wagon-axle.	Ratio of loading to transport capacity of wagons	Average receipts for the transport of all goods:			Ratio of goods-traffic receipts to gross general receipts.	in special trains.		rolling stock carried as goods.	for transports by passenger trains and others.	for transports by express trains.	for transports by slow-freight trains.	Other supplementary receipts not depending on traffic.
					Per cent.	per verst of length of track.	per pood of goods.	per pood-verst of goods.	Per cent.	Imperial trains.	Trains for government employees and private persons.					

Table VII (continued). — **Transports and gross receipts of railways during financial year.**

1	2	175	176	177	178	179	180	181	182	183	184	185	186	187	188	189
Index number.	DESIGNATION OF LINE.	Supplementary receipts.														
		Including :								Other supplementary receipts not depending on traffic.	Including :					
		weighing.	station expenses.	loading, unloading, etc.	warehousing.	hire of rolling stock.	registration.	insurance.	other receipts.		letting of lands and buildings.	hire of rolling stock.	telegraphs.	station refreshment-rooms.	financial and other supplementary operations.	other receipts.

Table VII (continued). — **Transports and gross receipts of railways during financial year.**

1	2	190	191	192	193	194	195	196	197	198	199	200	201
Index number.	DESIGNATION OF LINE.	Total amount of gross receipts.	Average gross receipts :			Including :							
			per verst of length of track.	per 100 train-versts.	per 10,000 axle-versts of trucks.	receipts for transport per passenger and mixed trains.		receipts for quick-freight transport. by goods trains.		receipts for slow-freight transport. by goods trains.		Supplementary receipts.	
						Total.	Percentage of total amount of gross receipts.	Total.	Percentage of total amount of gross receipts.	Total.	Percentage of total amount of gross receipts.	Total.	Percentage of total amount of gross receipts.

Table VIII. — **Working expenses during financial year.**

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Index number.	DESIGNATION OF LINE.	Length of track operated at end of financial year.	Expenses of central and local administration.											
			Expenses of central administration.											
			Board of administration	Service of receipts :			Other expenses of central administration :							Total expenses for central administration.
				staff, costs of lodging, inventory, and office expenses.	common control or clearing-house.	total.	relief funds, pensions and gratuities.	cost of schemes for betterment of working.	legal expenses.	costs of indemnities for injuries caused in the working.	fire insurance.	miscellaneous and occasional expenses.	total.	
		Versts.	Roubles.											

Table VIII (continued). — **Working expenses during financial year.**

1	2	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
Index number.	DESIGNATION OF LINE.	Expenses of central and local administration.													Service of way and works.		
		Expenses of local administration :								Total :						Supervision of way, bridges, tunnels, etc. : their maintenance and repair.	
		costs of manager, and management departments.	costs of medical service :				general expenses of economic department.	general expenses of all management services of system.	total expenditure for local administration.	general total.	per verst operated.	per 100 train-versts.	per 10,000 wagon-axle-versts.	percentage of costs of administration and services.	Costs of central service.	Costs of staff, lodging and clothing.	Maintenance and renewal of inventory.
			staff, costs of lodging and offices.	maintenance and renewal of inventory.	medicines, sickness expenses, burial expenses and other occasional expenses.	total.											
		Roubles.												Per cent	Roubles.		

Table VIII (continued). — **Working expenses during financial year.**

1	2	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47
		Service of way and works.															
		Supervision of way, constructive works, etc.; their maintenance and repair.											Supervision of buildings and water piping; their maintenance and repair.				
Index number.	DESIGNATION OF LINE.	Lighting of way, constructive works, crossings and line signals.	Maintenance and repair of embankments, declivities and ditches	Maintenance and repair of constructive works.	Repair of level crossings.	Cost of ballast.	Cost of sleepers.	Cost of rails and their fastenings.	Maintenance of permanent way during winter season.	Maintenance and repair of plant of permanent way and stations.	Repair of docks and quays.	Total.	Costs of staff, lodging and clothing.	Maintenance of railway buildings, hospitals, baths and other places of habitation.	Repair of passenger stations and their appurtenances.	Repair of goods yards and their appurtenances.	Repair of workshops, stock, sheds and water supplies.
		Roubles.															

Table VIII (continued). — **Working expenses during financial year.**

1	2	48	49	50	51	52	53	54	55	56	57	58	59	60	61	62	63	64
		Service of way and works.											Locomotive and rolling stock service.					
		Supervision of buildings and water-pipes; their maintenance and repair.						Total costs of service of way and works:						Traction (locomotive service).				
Index number.	DESIGNATION OF LINE.	Repair of buildings of economic service.	Repair of buildings for military service.	Other expenses of maintenance of buildings, sheds, yards, etc.	Maintenance and repair of water-pipes.	Costs of utilization, of common, or foreign stations.	Total.	total.	per verst operated.	per 100 train-versts.	per 10,000 wagon-axle versts.	percentage of administrative and service-costs.	Costs of central services.	Costs of staff, lodging and clothing.	Maintenance and renewal of the inventory of service sites.	Maintenance and renewal of locomotives.	Heating, lighting and other expenses of buildings.	Heating of locomotives, bonuses, etc.
		Roubles.										Per cent	Roubles					

Table VIII (continued). — **Working expenses during financial year.**

1	2	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80	81
Index number.	DESIGNATION OF LINE.	Locomotive and rolling stock service.																
		Traction.							Maintenance of wagons.									
		Lighting of locomotives.	Greasing of locomotives and tenders.	Cleaning of locomotives, tenders and boilers.	Water supply of locomotives.	Costs of water supply for benefit of foreign lines, etc.	Bonuses to heads of depots and other agents.	Total.	Costs of staff, lodging and clothing.	Maintenance and renewal of inventory of workshops, warehouses, instruments, etc.	Heating, lighting and cleaning of sheds, etc.	Costs of maintenance of warehouses for spares.	Heating of wagons.	Lighting of wagons.	Greasing of wagons.	Cleaning and disinfection of wagons.	Adaptation to military transport.	Total.
		Roubles.																

Table VIII (continued). — **Working expenses during financial year.**

1	2	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98
Index number.	DESIGNATION OF LINE.	Locomotive and rolling stock service.																
		Maintenance of workshops for repair of rolling stock.				Renewal and repair of locomotives and tenders.	Renewal and repair of wagons.					Hire of rolling stock.	Total costs of locomotive and rolling stock service.					Working, telegraph and telephone service.
		Costs of staff, lodging, clothing, inventory and office.	Maintenance and renewal of inventory of workshops.	Costs of heating, lighting, etc. of workshops.	Total.		Renewal and repair of coaching vehicles, with the exception of axles.	Renewal and repair of goods wagons.	Renewal and repair of axles, wheels and tires of wagons.	Fines arising out of exchange o spares.	Total.		Total.	Per verst operated.	Per 100 train-versts.	Per 10,000 truck-axle-versts.	Percentage of costs of administration and services	Costs of central service.
		Roubles															Percentage.	Roubles.

Table VIII (continued). — **Working expenses during financial year.**

1	2	99a	99b	100	101	102	103	104	105	106	107	108	109	110	111	112	113	114
Index number.	DESIGNATION OF LINE.	Traffic, telegraph and telephone service.																
		Station service.												Train service.				Telegraph and telephone.
		Costs of staff and their accommodation.	Costs of commercial service staff and clothing of station staff.	Maintenance and renewal of sheets for trucks and other accessories for the conveyance of goods.	Maintenance and renewal of weighing apparatus and other stock.	Cleaning, heating and lighting of buildings for passengers, goods, service, signals, permanent way and yards.	Loading and unloading of luggage, goods, and working of wagons, by animal traction.	Customs dues.	Costs of passenger tickets.	Costs of way-bills and other documents.	Costs of maintenance of common lines.	Fines arising out of exchange and utilization of rolling stock.	Total.	Costs of staff, accommodation and clothing.	Maintenance and renewal of inventory of train service.	Lighting of wagon signal-lamps.	Total.	Costs of staff, clothing, accommodation, inventory and offices.
		Roubles.																

Table VIII (continued). — **Working expenses during financial year.**

1	2	115	116	117	118	119	120	121	122	123	124	125	126	127	128	129	130
Index number.	DESIGNATION OF LINE.	Traffic, telegraph and telephone service.								Grand total of costs of administration and services						Other expenses.	
		Telegraph and telephone.			Total costs of traffic, telegraph and telephone service.											Obligatory expenses.	
		Maintenance and repair of gear.	Maintenance of common telegraph offices.	Total.	Total.	Per verst operated.	Per 100 train-versts.	Per 10,000 wagon-axle-versts.	Percentage of costs of administration and services.	Total.	Per verst operated.	Per 100 train-versts.	Per 10,000 wagon-axle-versts.	Per 1,000,000 pood-versts.		Costs of managers and government inspectors.	Costs of police.
														Paying load.	Gross load.		
		Roubles.							Per cent.	Roubles.						Roubles.	

Table VIII (continued). — **Working expenses during financial year.**

1	2	131	132	133	134	135	136	137	138	139	140	141	142	143	144	145	146	147
Index number.	DESIGNATION OF LINE.	Other expenses.												Total working expenses.				
		Obligatory expenses.						Expenses arising out of extraordinary events.	Costs of financial and auxiliary operations.				Costs of administrative transports.	Total.	Per verst operated.	Per 100 train-versts.	Per 10,000 wagon-axle-versts.	Percentage of expenditure to gross receipts.
		Costs of maintenance of homes for railway invalids.	Costs of railway technical schools.	Costs of non-technical schools, churches and hospitals.	Rates, taxes and stamp-duties.	Costs of crossings with navigable ways, lines of access, and other necessary outlays.	Total.		Losses attaching to balance-sheet account.	Losses attaching to auxiliary operations.	Losses attaching to economic service.	Total.						
		Roubles.												Roubles.				

Table IX. — **Results of railway operation during financial year.**

1	2	3	4		5	6	7	8	9	10	11	12	13	14	15	16
Index number.	DESIGNATION OF LINE.	Length of track in operation at end of financial year.	Length of double track at end of year.		Date of opening for traffic.	Date of redemption of railway.	Date of end of concession.	Mileage of trains.			Mileage of wagon-axles.			Average composition of trains.		
			Versts.	Per cent.				Total.	Including: passenger, mixed and quick-freight trains.	slow-freight trains.	Total.	Including: passengers, mixed and quick-freight trains.	slow-freight trains.	Total.	Including: passenger, mixed and quick-freight trains.	slow-freight trains.
		Versts.	Versts.	Per cent.	Day, month and year.			Train-versts.			Thousand-axle-versts.			Axles.		

Table IX (continued). — **Results of railway operation during financial year.**

1	2	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32
Index number.	DESIGNATION OF LINE.	Mileage of passengers and goods.									Gross receipts.						
		Effective mileage (reckoning one passenger at 5 poods).	Passenger mileage.	Pood-versts, transports by passenger, mixed and quick-freight trains.					Total of passenger-versts by passenger, mixed and quick-freight trains.	Total of pood-versts conveyed by slow-freight trains.	Total amount of gross receipts.	Per verst of length of track.	Including:				
				Luggage.	Goods by passenger, mixed and quick-freight trains.	Military effects.	Transports by the piece and cattle.	Total of passenger-versts.					by passenger, mixed and quick-freight trains.	by slow-freight trains.	receipts independent of traffic apportioned with reference to receipts dependent of traffic. Total.	Including: for mileage of passenger, mixed and quick-freight trains.	Including: for mileage of slow-freight trains.
		Million pood-versts.	Thousand passenger-versts.							Thousand pood-versts.	Roubles.						

Table IX (continued). — **Results of railway operation during financial year.**

1	2	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48
Index number.	DESIGNATION OF LINE.	Working expenses.															
		Total.	Per verst of length of track.	Per 100 train-versts.	Per 10,000 wagon-axle-versts.	Per 1,000,000 pood-versts of paying load.	Rate per cent of expenditure to gross receipts.	Including: expenditure pertaining to passenger traffic.	Including: expenses pertaining to goods traffic.			Including: expenses apportioned in relation to train-versts.			Including: expenses apportioned in relation to wagon-axle-versts.		
									Total.	Including: mixed and quick-freight trains.	Including: slow-freight trains.	Total.	Including: passenger, mixed and quick-freight trains.	Including: slow-freight trains.	Total.	Including: passenger, mixed and quick-freight trains.	Including: slow-freight trains.
		Roubles.						Roubles.									

Table IX (continued). — **Results of railway operation during financial year.**

1	2	49	50	51	52	53	54	55	56	57	58	59	60	61	62
Index number.	DESIGNATION OF LINE.	Working expenses.								Net receipts :				Apportionment of net receipts :	
		Including :													
		total expenses depending on traffic.			expenses not depending on traffic, and apportioned in relation to those depending on traffic.			total. expenditure :				total.			
		Passenger, mixed and quick-freight trains.	Slow-freight trains.	Total.	Passenger mixed and quick-freight trains.	Slow-freight trains.	Total.	belonging to passenger, mixed and quick-freight train traffic.	belonging to quick-freight train traffic.	passenger, mixed and quick-freight trains (— deficit).	slow-freight trains (— deficit).	General total (— deficit).	Per verst of length of track.	endowment of reserve funds, renovation and other special funds.	interest and repayment of loans received in virtue of guarantee of floating debts and others.
		Roubles.								Roubles.					

Table IX (continued). — **Results of railway operation during financial year.**

1	2	63	64	65	66	67	68	69	70	71	72	73	74		75	76
Index number.	DESIGNATION OF LINE.	Distribution of net receipts :			Deficit.	Annual payment of sums for interest and amortization :						Total expenditure with annual payment.	Surplus or deficit.		Rate per cent of expenses depending on traffic:	
		payment to credit of government		dividends on stocks, etc.		obligatory.	optional.		Total.	apportioned in relat on to working expenses			Total.	Per verst.	to the total amount of working expenses.	to the total expenditure, including sums for interest and amortization.
		Guarantee debs.	Real-estate expenses.				for stock not guaranteed (at 4 per cent).	for other expenses (at 4 per cent).		Passenger, mixed and quick-freight trains.	Slow-freight trains.					
		Roubles.														

Table IX (continued). — **Results of railway operation during financial year.**

1	2	77	78	79	80	81	82	83	84	85	86	87	88	89	90	91
Index number.	DESIGNATION OF LINE.	Per passenger-verst in passenger, mixed and quick-freight trains :							Per pood-verst in slow-freight trains :							Ratio of the cost of passengers, mixed and quick-freight trains to the costs of slow-freight trains.
		average receipts.	average working expenditure.	average net receipts (— deficit).	interest and annual amortization of capital having relation to the passenger, mixed and quick-freight train traffic.	total expenses, including interest and amortization of capital.	profit (+), loss (—).	average expenditure dependent on traffic.	average receipts.	average working expenditure.	average net receipts (— deficit).	interest and amortization of capital in relation to slow-freight traffic.	total expenses, including sums for interest and amortization.	profit (+), loss (—).	average expenditure dependent on traffic.	
		Copecks.							Copecks.							

Table X. — **Accidents during financial year.**

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
Index number.	DESIGNATION OF LINE.	Lenght of lines operated at end of financial year.	I. Derailments of trains and rolling stock.																				
			Derailments :			Including :		Analysis of the number of derailments according to cause.														Value destroyed (roubles) :	
			on the line.	in the stations.	total.	derailment of trains, or portions of trains.	derailment of rolling stock during shunting.	Obstruction of permanent way.		Faulty working of signals :		Defective make-up of trains and their direction.	Breaking of rails.	Defect in superstructure.	Defect in formation level and constructive work.	Defect in condition of points.	Defects in rolling stock :			Other causes :		belonging to railway.	belonging to third parties.
										points.	swing-bridges.						Breaking of axles.	Breaking of tires.	Other defects of stock.	ascertained.	not ascertained.		

Table X (continued). — **Accidents during financial year.**

1	2	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40
Index number.	DESIGNATION OF LINE.	II. Train and rolling-stock collisions.															
		Number of collisions:			Including:		Analysis of number of collisions according to cause:									Value destroyed (in roubles):	
		on the line.	in the stations.	total.	collision of trains or rolling stock.	collision of rolling stock whilst shunting.	fault of stations.	faulty working of points.	faulty signalling.	infringement of signalling rules.	entry into station at excessive speed.	faulty shunting of rolling stock.	train-breaks.	other causes: ascertained.	other causes: not ascertained.	belonging to railway.	belonging to third parties.

Table X (continued). — **Accidents during financial year.**

1	2	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60
Index number.	DESIGNATION OF LINE.	III. Other accidents connected with train service.																	Summary.		
		Number of accidents:			Including:											Value destroyed (in roubles):		Total number of accidents.	Analysis of accidents:		
		on the line.	in the stations.	total.	collisions of trains and rolling stock: with trolleys and hand-cars.	with equipages.	with cattle.	wilful obstruction.	fires in trains: passengers, military and workmen's trains.	fires in trains: goods.	boiler explosions.	breakage of axles.	breakage of tires.	train breaks.	other accidents.	belonging to the railway.	belonging to third parties.		per 100 versts of length of track.	per 100,000 train-versts.	per 1,000,000 wagon axle-versts.

Table X (continued). — **Accidents during financial year.**

1	2	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80	81
Index number.	DESIGNATION OF LINE.	IV. Other accidents to persons:						Total.			V. Accidents independent of traffic:							Other accidents to persons independent of traffic:			Total accidents independent of traffic.	Accidents to persons independent of railway working.
		fallen under trains and stock.	fallen from trains in motion.	during entry and exit of wagons.	crushed by buffers and accidents during shunting.	others.	total.	Number of accidents to persons.	Value destroyed (roubles): belonging to railway.	Value destroyed (roubles): belonging to third parties.	Total.	including: force majeure: superstructure.	including: force majeure: declivities.	including: force majeure: bridges, tunnels, etc.	including: fires: buildings.	including: fires: others.	other accidents independent of traffic.	in the workshops.	during loading, unloading, etc.	total.	Number.	Number of accidents.
		Number of accidents.																Number of accidents				

Table XI. — **Number of persons killed and injured during financial year.**

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33
Index number.	DESIGNATION OF LINE.	Length of lines operated at end of year.	Total passengers conveyed.	Passenger (mileage in versts).	Total train mileage (in versts).	Passenger train mileage (in train-versts).	Total mileage of locomotives, excepting double-heading and reserves.	Number of persons killed or injured during course of traffic.																										
								Passengers.																										
								Total.			Analysis of number of passengers killed or injured: according to nature of accidents: derailment.		collisions.		other accidents.		according to nature of faults: without fault of their own		through their own fault or imprudence.		Summary: per million of passengers conveyed.		per 1,000 million passenger-versts.			per million train-versts.			per million train-versts run by passenger-trains.		
								K.	I.	T.	K.	I.	K.	I.	K.	I.	K.	I.	K.	I.	K.	I.	T.	K.	I.	T.	K.	I.	T.	K.	I.	T.	K.	I.	T.

Table XI (continued). — **Number of persons killed and injured during financial year.**

1	2	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61	62	63	64	65	66
Index number.	DESIGNATION OF LINE.	Number of persons killed and injured.																																
		Railway employees and workmen.																																
		Total.			Analysis of total number of employees and workmen killed and injured																						Average :					
					according to nature of accident :								according to nature of fault :				by profession :																	
					derailment.		collision.		shunting.		other accidents.		without fault of their own.		through their own fault or imprudence.		engine-drivers and firemen.		head guards and conductors.		pointsmen.		foremen of gangs.		line-keepers.		other employees.		per million of train-versts.			per 1,000 million of train-versts.		
		K.	I.	T.	K.	I.	K.	I.	K.	I.	K.	I.	K.	I.	K.	I.	K.	I.	K.	I.	K.	I.	K.	I.	K.	I.	K.	I.	K	I.	T.	K.	I.	T.

Table XI (continued). — **Number of persons killed and injured during financial year.**

1	2	67	68	69	70	71	72	73	74	75	76	77	78	79	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98
Index number.	DES GNATION OF LINE.	Number of persons killed or injured during course of traffic																						Number of persons killed and injured independently of trains.							Other persons killed and injured independently of the working.		
		Third parties.										Total number of persons killed and injured.																					
		Total.			Including :				Average :			Total.			Including :				Average :			Including suicides.		Total.			Including :						
					through no fault of their own.		through their own fault or imprudence.		per million of train versts.						through no fault of their own.		through their own fault or imprudence.		per million of train versts.							through no fault of their own.		through their own imprudence.					
		K	I.	T.	K.	I.	K.	I.	K.	I.	T.	K.	I.	T.	K.	I.	K.	I.	K.	I.	T.	K	I.	K.	I.	T.	K.	I	K.	I.	K.	I.	T.

ANNEX II

Statistical annexes to the returns for each financial year introduced by the commission of 1884.

(Tables I to XIV.)

Table I. — General particulars of the line.

1. Date of the concession or other documents of title, and subsequent alterations made in the original acts (with indication of the articles modified). 2. Date of the opening of line (per sections). 3. Length of line operated. 4. Length of time scales of rates applied. 5. Virtual length : *a*) up ; *b*) down. 6. Commencement and end of concession (if the conditions differ according to sections) for each section separately. 7. Term of redemption according to concession.

Table II. — Total length of lines.

Designation : I. Length of running line. II. Length of branch lines. III. Length of service branch lines. IV. Length of branch lines belonging to private persons.	Length of single track.	Including :								
		running line			sidings of all kinds					
		total	that is to say :		total		that is to say :		
			single line.	double line.	versts.	ratio to length of main lines.	sidings.	reserve lines.	locomotive lines.
	Versts.						Versts.		

Table III. — Data regarding rails and sleepers.

I. On main lines. II. On commercial branch-lines. III. On service lines.	Kind of rails, their type and date of laying.	Rails.								Sleepers.							
		Number of versts of rails :								Kind of sleepers.	Number of sleepers :						
		on main lines				on sidings					on main lines				on sidings		
		first.	second.	total.	total per type.	sidings.	others.	total.	total per type.		first.	second.	total.	total per type.	sidings.	others.	total.	total per type.

Table IV. — **Data regarding permanent way, constructive works, crossings, and accessories of line.**

1			2		3	4	5						6						7		8		9	10		
Number of administrative sections and their respective lengths.			Length of track between stations (versts).		Description of portions of line situated between the stations.	Length of main lines on the flat.	Length of up gradients :						Length of down gradients :						Maximum length and height of up gradients.		Maximum length and height of down gradients.		Length of flats.	Length of curves.		
Permanent way service.	Traffic service.	Traction (locomotive) service.	Actual distance between centres of stations.	Length of time scales of rates applied.			more than 2 and up to 4 per mil.	more than 4 and up to 6 per mil.	more than 6 and up to 8 per mil.	more than 8 and up to 10 per mil	more than 10 per mil : that is to say : more than 125 per mil, and so on.		more than 2 and up to 4 per mil.	more than 4 and up to 6 per mil.	more than 6 and up to 8 per mil.	more than 8 and up to 10 per mil.	more than 10 per mil : that is to say : more than 125 per mil, and so on.		Height.	Length.	Height.	Length.		Radius : 600 sagenes and more.	Radius : less than 600 sagenes and more than 300 sagenes.	Radius : 300 and more than 150 sagenes.
							Versts.						Versts.						Sagenes.					Versts.		

Table IV (continued). — **Data regarding permanent way, constructive works, crossings, and accessories of line.**

10		11		12				13				14		15				16		17		18				19	
Length of curves.		Maximum length of a curve of radius : 300 sagenes and less.		Virtual length and coefficient.				Length of embankments and cuttings.				Tunnels.		Surface of formation level.				Length of side ditches.		Culverts in wood.		Culverts in iron :				Culverts in stone :	
Radius : 150 sagenes and less : that is to say :				Up.		Down.		Embankments :		Cuttings :				Embankments :		Cuttings :						diameter : 0·3 sagene.		diameter 0·5 sagene.		opening : 0·30 sagene.	
150 sagenes.	and so on.	length.	radius	Virtual length.	Coefficient.	Virtual length.	Coefficient.	height to 1 sagene.	height of more than 1 sagene.	depth to 1 sagene.	depth of more than 1 sagene.	Number.	Total length in sagenes.	covered with stones.	covered with fascine-work and mixed	covered with stones.	covered with fascine-work and mixed	earth-ditches.	other.	Number.	Length in sagenes.	Number.	Length in sagenes.	Number.	Length in sagenes.	Number.	Length in sagenes.
Versts.		Sagenes.						Versts.						Square sagenes.				Sagenes.									

Table IV (continued). — **Data regarding the permanent way, constructive works, crossings, and accessories of line.**

19	20					21										22									
Stone drains.	Wooden bridges.					Culverts with opening up to 2 sagenes (included) upon stone or metal supports.										Bridges with span exceeding 2 sagenes upon stone or metallic supports.									
Opening 0·50 sagene:	Height of supports up to 3 sagenes:			Height of supports of more than 3 sagenes:		Wooden beams:						Metal girders:				Single part:									
						a) height of supports up to 2 sagenes:			*b*) height of supports of more than 2 sagenes:			*a*) height of supports up to 2 sagenes:			*b*) height of supports of more than 2 sagenes	*a*) height of supports up to 3 sagenes:			*b*) height of supports of 3 to 5 sagenes:			*c*) height of supports of more than 5 sagenes:		
number.	number.	total length of crest.	including compound beams.	number.	total length of crest.	including compound beams.	span: 0·00 sagene	span: 0·00 sagene.	and so on.	span: 0·00 sagene.	span: 0·00 sagene.	and so on.	span: 0·00 sagene.	span: 0·00 sagene.	and so on.	span: 0·00 sagene.	span: 0·00 sagene.	and so on.	span: 0·00 sagene.	span: 0·00 sagene.	and so on.	span: 0·00 sagene.	span: 0·00 sagene.	and so on.
and so on.																									

Table IV (continued). — **Data regarding permanent way, constructive works, crossings, and accessories of line.**

22						23		24			25											
Bridges with spans exceeding 2 sagenes, upon stone or metal supports.						Other constructive works.		Crossings:			Accessories of line:											
Multiple parts:										Area:			fixed line signals:									
position of bridge.	length of bridge.	span.	number of supports.	average height of support	height above level of water.	Designation of works.	Number.	number.	including non-guarded.	wood.	paving.	gradient boards.	indicators of limits of sections, districts, etc.	semaphore.	green disks.	bells.	blocks.	other signals.	length of snow screens.	length of quickset hedges.		
	Sagenes.			Sagenes.						Sagenes.		Number							Sagenes.			

Table V. — **Data regarding lands taken over, buildings and works of stations and permanent way.**

Index number.	DESIGNATION OF STATIONS AND THEIR CLASSES.	Lands taken over.	Height of platform.	Length of track : total.	Length of track : including sidings	Length of track : Sagenes.	INDICATION OF NATURE OF BUILDINGS AND WORKS.	Passenger buildings : with habitations.	Passenger buildings : without habitations.	Passenger platforms : corresponding with buildings	Passenger platforms : situated between the lines	Barriers on platforms.	Water-closets.	Lamp department	Goods platforms : covered.	Goods platforms : open.	Temporary arrangement for goods.	Goods sheds.	Goods offices.	Water-closets.	Weighing apparatus.	Arrangements for watchmen.	Arrangements for doorkeepers.

Table V (continued). — **Data regarding lands taken over, buildings and works of stations and permanent way.**

Habitations					Subsidiary installations near buildings :									Buildings of special character :								
pointsman's boxes : single.	pointsman's boxes : double.	barracks : single.	barracks : double.	other type	separate kitchens.	sheds.	refrigerators.	wells.	baths.	laundries.	water-closets.	pits.	other services.	fences.	churches.	schools.	hospitals.	locomotive sheds.	wagon sheds.	work-shops.	warehouses.	sheds for military installations.	cellars for inflammable goods	fire-engine depots.

Table V (continued). — **Data regarding lands taken over, buildings and works of stations and permanent way.**

Other buildings, with indication of their nature.	Area of court-yards and ways of access to stations, paved.	Telegraph.			Opticals signals.			Electric bells.	Station accessories.													
		Number of wires.	Number of apparatus :		Disks :		Semaphores.		Weigh-bridges :		Points.	Crossings, frogs.	Switch sleepers :		Triangles.	Swing-bridges.	Traver-sers :		Lifting apparatus.	Bars.	Ash pits.	Pointsman's boxes.	Block signal box.	Locking frame in signal tower.
			telegraphic.	telephonic.	green.	red.			open.	covered.			number.	sagenes.			locomotives	wagons.						

Table V (continued). — **Data regarding lands taken over, buildings and works of stations and permanent way.**

Buildings and apparatus for water-supply.																							
Water-cranes :		Capacity of reservoirs	Habitations near waterworks.	Watercranes.	Other habitations.	Springs :		Height.	Boilers	Engine power.	Description of apparatus for raising water.	Length of electric wire	Water pipes :						Taps and cocks :					
													suction.		com-pression.		Distribution.							
single.	double.					designation.	quantity of water per day.						Length.	Diameter.	Length.	Diameter.	Length.	Diameter.	supply.	washing.	sprinkling.	suction.	fire.	stop.

Table VI. — **Data relating to locomotives and tenders, and relative installations.**

Locomotives.															
CLASS OF LOCOMOTIVES.	Series.	Number.	Manufactory.	Date when put in service.	Cylinders.			Boilers.				Heating surface.			Maximum of steam pressure beyond one atmosphere.
					Diameter.	Piston stroke.	Position.	Diameter.	Length of tubes between tube plates.	Number of heating tubes.	External diameter of heating tubes.	Total.	Including: exterior of heating tubes.	Including: the combustion chamber.	
					Millimetres.			Millimetres.			Millimetres.	Square millimetres.			
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16

Table VI (continued). — **Data relative to locomotive and tenders, and relative installations.**

Locomotives.													Tenders					Number of locomotive sheds.	
Axles: Number.		Axles: Diameter of wheels:		Axles:	Weight:			Tractive effort according to formula.	Analysis of number of locomotives indicated in column 3 according to nature of fuel.				Axles:		Weight:				
Total.	Including driving.	coupled.	running-wheel.	Wheelbase.	without fuel or water.	with fuel and water.	per driving axle.		Nature of fuel.	Number of locomotives.	System of locomotives.	Number of locomotives.	number	diameter of wheels.	empty.	loaded.	Water capacity of tenders.	Total.	Ratio to number of locomotives. Per cent.
17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36

Table VII. — **Data regarding number of cars and relative installations.**

KIND OF CAR.	Series.	Manufactory.	Date when brought into service.	Number of cars: total.	Number of cars: including brake-vans.	Nature of brakes.	Number of axles of cars.	Average weight per vehicle.	Number of seats.	Capacity per wagon (poods).	Total: trucks.	Total: axles.	Total: seats.	Total: capacity.	Capacity of installations for coaching vehicles: total per car.	Capacity of installations for coaching vehicles: ratio to the total number of coaching vehicles.
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17

Table VIII. — **Data regarding number and plant of central and secondary workshops.**

DESIGNATION OF CENTRAL AND SECONDARY WORKSHOPS.	Area of covered installations for: repair of locomotives.	Area of covered installations for: repair of cars.	Area of covered installations for: mixed, for repair of locomotives and cars.	Number of places set apart in workshops for: repair of locomotives without tenders	Number of places set apart in workshops for: ratio to total number of locomotives.	Number of places set apart in workshops for: ratio to total number of cars.	Number of places set apart in workshops for: ratio to total number of cars.	Length of workshop and depot lines: Total.	Length of workshop and depot lines: including for repair of cars.	Capacity of all engines of workshops.	Number of fires and furnaces: permanent furnaces, number of fires.	Number of fires and furnaces: number of cupola furnaces.	Number of fires and furnaces: number of other furnaces.	Number of hammers.
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15

Table VIII (continued). — **Data regarding number and plant of central and secondary workshops.**

Maximum number of casts per month.		Number of machine-tools for metal working:									Wooden-working machines.	Total:			Average number of artisans and workmen.	*Remarks.*
Cast iron.	Cast brass.	Total.	furnace for wheels of locomotives.	furnace for wheels of cars.	others.	drills.	planing-machines.	mortise machines.	screw-cutting machines.	others for metal		fitter's vices.	benches.	grind-stones.		
16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32

Table IX. — **Data regarding maximum commercial transport capacity of line.**

Section number.	BY SECTIONS AND DIRECTIONS.	Maximum number of trains with reference												Transport capacity with reference	
		to the permanent way and other installations						to the water supply						effective force of rolling stock (cars).	effective force of stock for certain periods of heavy traffic (maximum).
		by direction						by direction							
		up.			down.			up.			down.				
		Kind of trains.	Number.	Speed.	Kind of trains.	Number.	Speed.	Kind of trains.	Number.	Speed.	Kind of trains.	Number.	Speed.		

Table X. — **Data regarding traffic, receipts and mileage of rolling stock.**

(Results of the working for four successive years and the budget anticipations for the financial year.)

I. — Passengers and transports at quick-freight tariffs and corresponding receipts.

1) Total receipts derived from special trains for the Imperial family, the government and private persons. 2) Number of passengers at fares of all kinds (remunerative). Including : 3) Number of through passengers. 4) Number of passengers at ordinary fares. 5) Number of passengers at military tariff. 6) Number of passengers carried on special conditions. 7) Number of prisonners and their escorts. 8) Mileage of all passengers at remunerative fares. 9) Average mileage (versts) of a passenger at remunerative fares. 10) Total receipts derived from transport of all passengers at remunerative fare. 11) Total average receipts in respect of each passengers (verst, remunerative). 12) Total number of free passengers. 13) Mileage of free passengers. 14) Average mileage of each free passenger. 15) Total weight of luggage. 16) Pood-versts of luggage. 17) Average mileage of each pood of luggage. 18) Total luggage receipts. 19) Average receipts per pood-verst of

Table X. (Continued.)

luggage. 20) Total weight of parcels and goods by quick freight. 21) Including military effects. 22) Total pood-versts of parcels and goods by quick freight. 23) Including military effects. 24) Average mileage of each pood of parcels and goods by quick freight. 25) Ditto of military effects. 26) Total receipts from parcels and goods by quick freight. 27) Including military effects. 28) Average receipts per pood-verst of parcels and goods by quick freight. 29) Ditto per pood-verst of military effects. 30) Total number of poods conveyed by the piece. 31) Including transports at military tariff. 32) Total number of pood-versts by the piece. 33) Including transports at military tariff. 34) Average mileage of each pood by the piece. 35) Ditto of transports at military tariff. 36) Total receipts from transports per piece. 37) Including transports at military tariff. 38) Average receipts for each pood-verst, of transports per piece. 39) Ditto per pood-verst at military tariff. 40) Total number of poods of cattle. 41) Including cattle at military tariff. 42) Total number of pood-versts of cattle. 43) Including cattle at military tariff. 44) Average mileage of each pood of cattle. 45) Ditto of cattle at military tariff. 46) Total receipts from cattle transport. 47) Including cattle at military tariff. 48) Average receipts for each pood-verst of cattle. 49) Ditto for cattle at military rate. 50) Total receipts from postal traffic. 51) Supplementary receipts from passengers and quick freight transports. 52) Total receipts from all quick-freight transports. 53) Average receipts for each train-verst. 54) Average receipts for 10,000 wagon-axle-versts.

II. — Transports at slow-freight rates and corresponding receipts.

55) Total number of poods of goods conveyed at slow-freight rates per pood and per truck (fully loaded). [Including : 56) passed in transit; 57) conveyed at military tariff]. Analysis of total number of poods of goods by slow-freight; 58) conveyed in the up direction; 59) ditto in the down direction. 60) Total number of pood-versts of goods by slow freight. 61) Including transports at military tariff. Analysis of total number of pood-versts (60) : 62) Transported in the up direction. 63) Ditto in the down direction. 64) Average mileage of each pood of goods by slow freight. 65) Ditto of transports at military tariff. 66) Total receipts from goods by slow freight by the pood and by the wagon (fully loaded). 67) Including transports at military tariff. 68) Average receipts per pood-verst of goods by slow freight. 69) Ditto of transports at military tariff. 70) Total number of poods conveyed by the piece. 71) Including transports at military tariff. 72) Total number of pood-versts of transports by the piece. 73) Including transports at military tariff. 74) Average mileage of each pood of transports by the piece. 75) Ditto of transports at military tariff. 76) Total receipts from transports by the piece. 77) Including transports at military tariff. 78) Average receipts for each pood-versts of transport by the piece. 79) Ditto for transports at military tariff. 80) Total receipts from transport of rolling stock conveyed as goods, but circulating on own axles. 81) Total number of poods of cattle. 82) Including cattle at military tariff. 83) Total number of pood-versts of cattle. 84) Including cattle at military tariff. 85) Average mileage of each pood of cattle. 86) Ditto of cattle at military tariff. 87) Total receipts from cattle transport. 88) Including cattle transported at military tariff. 89) Average receipts per pood-verst of cattle. 90) Ditto of cattle conveyed at military tariff. 91) Number of poods conveyed for the needs of the working at service tariff. 92) Their mileage in pood-versts. 93) Total receipts from service transports. 94) Average tariff per pood-verst. 95) Supplementary receipts from slow-freight transports by slow-freight trains. 96) Total receipts from all slow-freight transports. 97) Ditto per train-verst. 98) Ditto per 10,000 axle-versts of wagons. 99) Number of way-bills at departure. 100) Ditto on arrival. 101) Number of stations of exchange of goods.

III. — Train mileage.

102) Total mileage of trains (versts). 103) Average number of trains per day for the whole line. 104) Mileage of fast and ordinary trains. These include : 105) Special trains for the Imperial family;

106) ditto for private persons; 107) ditto for administration; 108) fast and express; 109) postal and passenger; 110) mixed; 111) military; 112) junction. 113) Average number of slow-freight trains per day for the whole extent of the line. 114) Mileage of slow-freight trains (versts). These include: 115) goods trains; 116) military ditto; 117) administrative ditto; 118) junction ditto. 119) Average number of slow-freight trains per day for the whole extent of the line.

IV. — Mileage of rolling stock.

A. — Locomotive mileage: 120) Total mileage of locomotives. 121) Mileage of locomotives for all trains. 122) Including double-heading. 123) Mileage of locomotives for fast and ordinary trains. 124) Including double-heading. 125) Mileage of locomotives for slow-freight trains. 126) Including double heading. 127) Mileage of light locomotives, *i. e.*; 128) locomotives, alone; 129) reserve; 130) shunting. 131) Proportion per cent of mileage of locomotives without trains to train mileage.

B. — Mileage of cars and axles of cars: 1. *Mileage of home and foreign cars and corresponding axles to home system*: 132) Total mileage of all cars. 133) Total mileage of all axles, *viz.*: 134) *a*) Home stock on home system: cars; 135) ditto: axles. Including: 136) coaching vehicles; 137) ditto: axles. 138) Luggage, postal, service and prisonners' vans: vans. 139) Ditto: axles. 140) Goods wagons. 141) Ditto: axles. 142) *b*) Foreign stock on home system: cars. 143) Ditto: axles. Including: 144) Coaching vehicles: cars. 145) Ditto: axles. 146) Luggage, postal, service and prisonners' vans: vans. 147) Ditto: axles. 148) Goods wagons: wagons. 149) Ditto: axles. — 2. *Mileage of home cars and axles on foreign systems.* 150) Total mileage of cars. 151) Ditto of axles. Including: 152) Coaching vehicles. 153) Ditto: axles. 154) Luggage, postal, service and prisonners' vans: vans. 155) Ditto: axles. 156) Goods wagons. 157) Ditto: axles. — 3. *Mileage of home cars and axles on home and foreign systems*: 158) Total mileage of cars. 159) Ditto of axles. Including: 160) Coaching vehicles. 161) Ditto: axles. 162) Luggage, postal, service and prisonners' vans: vans. 163) Ditto: axles. 164) Goods wagons. 165) Ditto axles. — 4. *Analysis of mileage of home and foreign stock and axles relative to home system for nature of train: a) Mileage of stock in fast and ordinary trains*: 166) Coaching vehicles. 167) Goods wagons. 168) Others. 169) Axles. — *b*) *Mileage of stock in slow-freight trains*: 170) Coaching vehicles. 171) Goods wagons. 172) Others. 173) Axles.

V. — Composition of trains.

Average number of cars and axles. — *a*) *In fast and ordinary trains*: 174) Coaching vehicles. 175) Goods wagons. 176) Axles. — *b*) *In slow trains*: 177) Coaching vehicles. 178) Goods wagons. 179) Axles.

VI. — Number of pood-versts of tare of rolling stock.

180) Total number of pood-versts of tare of rolling stock, *viz.*: 181) Number of pood-versts of tare of locomotives and tenders. 182) Number of pood-versts of tare of cars (home and foreign on home system). Analysis of tare of rolling stock (poods): 183) per train-verst; 184) per 10,000 axle-versts.

VII. — General summary of traffic.

185) Number of passenger-versts per axle-verst of mileage of coaching vehicles. 186) Comparison of number of seats occupied and available per axle of coaching vehicle. 187) Average number of passengers per train. 188) Number of pood-versts per axle-verst of goods wagons. 189) Average number of poods of goods per slow-freight train. 190) Ration of paying load and loading capacity per axle of goods wagon. 191) Number of gross pood-versts conveyed on line.

Table XI. — Data regarding receipts and transports by quick and slow speeds per month (each month separately).

Index number	PASSENGERS AND TRANSPORTS BY QUICK SPEED (57 separate articles of transport).	January.			And so on.	December.			Total.			Total mileage. Versts.	Average mileage.	Average receipts per unit.	Average receipts per verst of mileage.
		Number.	Receipts: roubles.	Receipts: copecks.		Number.	Receipts: roubles.	Receipts: copecks.	Number.	Receipts: roubles.	Receipts: copecks.				

Table XII. — Data regarding quick and slow speed transports by stations (each station separately).

Index number.	PASSENGERS AND TRANSPORTS BY QUICK SPEED (39 articles of transport).	Designation of station on home system: at departure.	Designation of station on home system: on arrival.	Junction stations: at departure.	Junction stations: on arrival.	Total.

Index number.	SLOW-SPEED TRANSPORTS (11 articles of transport).	Designation of stations on home system: at departure.	Designation of stations on home system: on arrival.	Designation of lines: at departure.	Designation of lines: on arrival.	Total.

Table XIII. — **Data regarding station operations (each station separately).**

Index number.	DESIGNATION OF STATIONS AND THEIR CLASS.	Per quarter.	Average number per month.							
			Trains received and despatched :		Coaching vehicles :		Goods wagons :		Poods :	
			quick speed.	slow speed.	at departure.	on arrival	at departure.	on arrival.	loaded.	unloaded.
1	2	3	4	5	6	7	8	9	10	11

Table XIII (continued). — **Data regarding station operations (each station separately).**

Average number per month.													Remarks.
Passenger tickets.	Luggage tickets.	Way-bills :		Telegrams :		Gross receipts :		Shunting by special locomotives :					
								number :		versts :			
		at departure.	on arrival.	private.	services.	roubles.	copecks.	hours.	versts.	wagons at departure and on arrival.	1,000 poods of goods at departure and on arrival.		
12	13	14	15	16	17	18	19	20	21	22	23		24

Table XIV. — **Data regarding car mileage per month and by direction.**

Designation of months: a) up; b) down.	Number of trains and their mileage:						Number of cars and their mileage:								Number of poods and their mileage:					
	quick-freight.		slow-freight.		total.		loaded:				empty:				quick-freight.		slow-freight		total.	
							quick-freight trains.		slow-freight trains.		quick-freight trains.		slow-freight trains.							
	Number.	Mileage.	Number.	Mileage.	Number.	Mileage.	Number.	Mileage.	Number.	Mileage.	Number.	Mileage.	Number.	Mileage.	Poods.	Pood-versts.	Poods.	Pood-versts.	Poods.	Pood-versts.
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21

Table XIV (continued). — **Data regarding car mileage per month and by direction.**

Average number of goods wagons:						Average mileage of each goods wagon:						Average mileage of each pood:		Average load per loaded wagon:		Average load per wagon loaded and empty:		Average load per wagon.
by quick-freight train:			by slow-freight train:			loaded:			empty:									
loaded.	empty.	total.	loaded.	empty.	total.	quick-freight trains.	slow-freight trains.	total.	quick-freight trains.	slow-freight trains.	total.	quick freight.	slow freight.	quick-freight trains.	slow-freight trains.	quick-freight trains.	slow-freight trains.	
22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40

Note. — Tables I to X form annexes to the budget and annual returns; tables XI to XIV come only within the scope of the annual returns.

ANNEX III.

Table of temporary and periodical statistics regarding the position of the railways and their traffic.

I. — *General data relative to the condition of the railways.*

Annually (on the 1st January).

Working length of line and branches (from centre to centre of stations) *i. e.* : *a*) division into sections of line; *b*) mileage length of the second track; *c*) number and length of connecting lines and branches in private use; *d*) length of all other lines (locomotive, shunting, etc.); *e*) restrictions existing with regard to the circulation of rolling stock of certain types; *f*) arrangement of depots and number of locomotive sheds; *g*) number of trains in each direction corresponding to the distribution of water and to tender capacity; *h*) method of firing on each section; *i*) arrangement of sorting yards; *k*) plans and diagrams of home junction stations and points of exchange of stock, together with maritime and river stations. If there is reason to foresee changes during the course of the year, these will be indicated.

II. — *Transport capacity.*

Twice annually (1st September and 1st March).

These particulars will be given by sections, differing from each other according to degree of transport capacity.

A. — Number of regular trains up and down, leaving daily or periodically, *i. e.* leaving on certain days fixed in advance (express, fast, postal, mixed, total). Their composition (normal in axles) :

1° Coaching vehicles, luggage vans, vehicles for transport of prisoners, etc.;

2° Loaded goods wagons : *a*) up; *b*) down.

B. — 1. Daily number of all other classes of regular or periodical trains (no account being taken of trains included in paragraph *A*), *i. e.* : military trains, emigrant trains, fast goods, etc.

2. Maximum number of loaded axles of goods stock able to be conveyed by these trains in the directions of the traffic : *a*) up; *b*) down.

C. — Maximum number per day of auxiliary trains capable of being dispatched on each section, without counting the trains included in paragraphs *A* and *B* : *a*) using the ordinary installations; *b*) bringing into use all crossing points and auxiliary sidings provided for the commercial service in case of an unusual rush of traffic, indicating in the latter case the number of auxiliary trains.

Independently of these particulars, details are given of :

1. The normal make-up of the trains, *i. e.* the number of loaded axles of goods wagons in the directions : *a*) up; *b*) down.

2. Maximum length of trains corresponding with the length of sidings and others.

D. — Descriptive tables and books of routes.

III. — *Capacity of stations.*

Annually (on the 1st January).

Abstract of the junction stations, terminus stations and important points of departure and arrival of goods, and abstract of all stations where there is reason to fear difficulties in respect of the passage, receipt and departure of goods, with an indication :

1. Of the maximum daily number of wagons which the station can : *a*) load; *b*) unload; *c*) class according to nature of goods; *d*) admit to passage in transit; *e*) make up into trains, and *f*) exchange with neighbouring lines (on condition of receiving an equivalent number of wagons).

These particulars will correspond to the heaviest period of traffic within the limits of the graphic time-tables in force, as well as to the enlargement of stations provided for.

2. Maximum number of wagons capable of being dealt with during a day, with indication of conditions of labour, if the number of wagons does not depend solely on the quantities indicated above.

3. Maximum number of wagons capable of being put into depot at the stations without prejudice to their working capacity : *a*) total; *b*) including reserve wagons.

4. Length of the sidings, classing them by lines : *a*) for dispatch and receipt of trains; *b*) shunting; *c*) loading and unloading; *d*) service.

IV. — *Goods warehouses.*

Annually (on the 1st January).

Abstract of stations, with indication of capacity and platform area for loading :

1. Arrangements for the storage of goods awaiting their turn for dispatch, separately according to nature of goods, sheds platforms, etc.

2. Arrangements for storage of goods arrived and awaiting their delivery to consignees.

3. Long term storage, with indication : *a*) of the nature of the goods, and *b*) of the right of the railway to apply special tariffs according to warehouses : *a*) belonging to the railways, or *b*) incorporated therein.

4. Areas, capable of being placed at the disposition of bulk goods, together with the sheds temporarily appropriated for the use of bulk goods, awaiting their turn for despatch, with an indication of the number of gangs and mechanical appliances available for the loading, unloading and cleaning of the goods, etc. If any changes during the course of the financial year are foreseen they should be carefully indicated.

V. — *Fuel reserve.*

Monthly (on the 5th of the month following).

Particulars given separately for each kind of fuel with regard to the quantity : *a*) total on the 1st of the month; *b*) to hand during the month; *c*) used during the month, and *d*) remaining at the end of the month.

VI. — *Inventory of rolling stock.*

Annually (on the 15th January).

A. — Number of locomotives of each type, with as complete particulars as possible.

1. Series and manufactory.

2. Number and diameter of axles, carrying and driving.

3. Method of firing.

4. Effective force, and type of automatic brake.

5. Date of construction and last renewal of boiler.

6. Heating surface.

7. Boiler pressure and diameter of cylinders.

8. Axle load.

9. Date of last overhaul, and mileage effected since.

10. Tender capacity, number of axles and their loads.

B. — **Coaching vehicles, luggage vans, vehicles for the transport of prisoners, service vehicles, specials, etc.**

Number of vehicles of each type with indication of :

1. Kind (class, speciality, etc.).

2. Tare and number of axles.

3. Description of brakes.

4. Number of compartments (if any), and number of seats; night and day; as regards luggage vans, their capacity.

5. Method of heating and lighting.

C. — **Goods wagons.**

Number of wagons of each type, indicating :

1. Characteristic features of special wagons, and of the goods corresponding.

2. Number of axles.

3. Capacity (as regards open trucks, also the length).

4. Tare.

The brake-vans will be mentioned separately.

E. — **Motor cars.**

Their number, with particulars in each case of the number of axles, passenger seats for each class, and capacity for conveyance of goods.

These data should be for the 1st January. The stock incorporated with the railway will be indicated separately.

VII. — *Modification of inventory.*

Monthly (the 10th of the month following).

Effective force of rolling stock, with classification by categories as indicated in No. VI :

a) Ordered at the manufactories.

b) Received by the railway :

1. Date of receipt.
2. Date of being put into service.

c) Exclusion from its service :

1. Date of exclusion from service.
2. Date of exclusion from inventory.

d) Total modification during the corresponding month *b*-1 and *c*-2.

Care will be taken to indicate under headings *a* and *b* the name of the manufactory, the budgetary credit, and the name of the cessionary railway. Particulars will be given under the heading *c* if the stock has been sold or transferred to the inventory of a foreign railway, and the name of that line stated.

The particulars as a whole of section VII should explain the modifications of the inventory indicated in the abstract for the year (section No. VI).

VIII. — *Distribution of rolling stock.*

A. — **Locomotives.**

Daily (forty-eight hours after the end of the day) average returns per month (per sections of line), two weeks after the end of the month.

These particulars will include the following data :

a) 1° Inventory and 2° number (taking into consideration the hire of stock and its return).

b) 1° Under repair ; 2° awaiting their return for repair, and 3° out of use.

c) Number proper in service : 1° under steam; 2° being washed out, and 3° remaining available (see note 1).

The locomotives under steam will be divided into : working with 1° double crews, and 2° single crews, each category being divided according to the nature of the work : 1° passenger trains; 2° goods trains; 3° service trains; 4° running light; 5° shunting; 6° reserve.

Stoppages : *a*) at stations and in the trains; *b*) awaiting trains.

These records will be kept separately for : 1° passenger locomotives with two driving axles; 2° locomotives with three driving axles; 3° passenger locomotives with four or more driving axles; 4° composite locomotives; 5° goods locomotives with three driving axles; 6° goods locomotives with four driving axles; 7° goods locomotives with six driving axles; 8° tenders and tank locomotives, etc.; 9° motor cars.

The daily reports will furnish data for the whole system; the monthly reports, by sections of the transport (running) service (see note No. 3).

NOTE.

1. The figures inserted under the heading " remaining available " will be completed by an indication of the number of locomotives and wagons available for sending on foreign systems.

2. In order to obtain a more exact account of the mileage of each wagon, the analysis ought not only to show the exchange, the delivery up, the hiring and the debts in wagons, but should further mention the delivery of wagons at a fixed term without actual exchange of stock, as well as the transfer of passenger vehicles from one system to another, when these vehicles effect their mileages in through trains (for example, special saloons, etc.).

3. The analysis of rolling stock is effected at present according to daily reckoning. So far as locomotives are concerned, it will be effected in future according to locomotive hours.

B. — **Passenger vehicles.**

The average figures for each month will be presented two weeks after the end of the month.

a) 1° Inventory; 2° vehicles received and delivered up; 3° balance of the delivery up in through service; 4° remaining total.

b) 1° Under repair; 2° awaiting their turn for repair, and 3° out of use.

c) Inventory of vehicles able to ensure the service :

1. Of commercial and military trains;
2. Serving as lodging and entering into the composition of service trains;
3. Reserve;
4. Remaining available.

A separate calculation will be made for each type of carriage :

1. Special saloons, and service carriages, with two and three axles, ditto with four axles;
2. 1st class with two and with three axles; ditto, with four axles.

A separate account will be kept of carriages of two, three and four axles :

3. 1st-2nd class;
4. 2nd class;
5. 2nd-3rd class;
6. 3rd class;
7. 4th class:
8. Luggage vans;
9. Mail;
10. Prisoners;
11. Others.

C. — **Goods wagons.**

a) 1° Inventory; 2° hired and rented; 3° balance of debts in wagons and wagons delivered up at fixed date; and 4° total inventory.

b) 1° Repairs; 2° awaiting their turn for repair; 3° out of use.

c) Inventory of wagons fit for service :

1. Wagons in use for transport, under loading, unloading, reserve and forming part of the make-up of trains, with the exception of stock designated for passenger, military and service trains, divided into categories, *viz.* :

a) Through-service wagons;

b) Wagons temporarily unfit for through services;

c) Wagons unfit for through services :

2. Appropriated to the requirements of : *a*) service trains; *b*) military, and *c*) passenger.

3. Serving as lodging and for storing;

4. Delayed in course of route : *a*) loaded; *b*) empty.

5. Available surplus (note 1).

Each category will be divided according to the type of wagon, *i. e.* :

1. Covered wagons, normal pattern (with the exception of wagons with four axles).

2. Including wagons appropriated to passenger traffic.

3. Covered, with four axles.

4. Open, flat wagons.

5. High-sided wagons with two axles.

6. Wagons with four axles.

7. Special.

8. Trucks for transport of naphtha.

Covered wagons temporarily appropriated to the special goods service will not be excluded from the total number of covered wagons of normal pattern.

IX. — *Hire of rolling stock.*

Daily, the particulars enumerated under headings a, b, c, d, and, monthly, the data under headings e and f. Time allowed, the same as for section No. VIII.

a) Kind and number of rolling stock hired and rented at the commencement of the period, with indication of the proprietary line and the hiring line.

b) Category and number of rolling stock, returned or received, with indication of the corresponding line.

c) Category and number of stock received or returned, with indication of the corresponding line, and date of return.

d) Category and number of rolling stock remaining as balance of stock hired and rented towards the close of the period.

e) Number of days of renting of stock during the period, divided up according to categories of stock and proprietary or hiring lines.

NOTE.

1. The division according to categories of stock will be identical with that indicated in section No. VIII.

2. To meet the requirements of the technical statistics, each line will deduct the dates of delivery and return upon the basis of its own data, *i. e.*; for each wagon, the date (day) of its transfer by the ceding line or of its return in kind as well as by compensation (by entries); for each locomotive, the ceding line will deduct the day of departure from the depot, if the locomotive has to be transferred anywhere on the line; if the delivery takes place at the station at which the depot is situated, the day of the delivery of the locomotive to the foreign line, and *vice versa*.

X. — *Technical work of rolling stock and sections of line.*

Monthly (four weeks after the end of the month).

A. — Mileages of trains (train-versts).

The mileages will be divided according to categories of trains :

1. Fast; express, postal and passenger.

2. Other passenger trains (mixed, etc.).

3. Military trains.

4. Emigrant trains.

5. Other fast trains.

6. Goods.

7. Service.

8. Extra.

9. Locomotives running light.

All these particulars will be recorded separately according to direction (up and down) and by section of line (note 3).

B. — **Mileages of locomotives (locomotive-versts).**

The whole work of locomotives upon the portions of the line situated between the stations, including double traction (front and rear) will be set out in nine categories indicated under heading *A*, separately for the directions up and down.

As regards the work in the stations, this will be divided into: 1° shuntings by special locomotives; 2° shunting by passenger locomotives; 3° reserve (in the trains, at stations, and awaiting their turn for entry into the composition of trains. as well as at the depots).

The mileages for each of the twelve categories (9 + 3) will be mentioned separately for each section of line and according to the type of locomotive :

1. Passenger with 2 driving axles.
2. — — 3 — —
3. — — 4 — —
4. Mixed-goods — 3 — —
5. Goods — 3 — —
6. — — 4 — —
7. — — 6 — —
8. Tank locomotives.
9. Motor cars.

(Separately for double and single crews.)

C. — **Division of auxiliary mileages of locomotives on portions of the line situated between the stations.**

The mileages will be recorded separately :

1. Driving back.

2. Double traction of trains (by weight).

3. Double traction effected in place of mileages of locomotives running light.

4. Mileages of locomotives running light.

The total of the mileages under headings 3 and 4 will be divided up in accordance with the principal causes, *viz.*: *a*) uneven traffic; *b*) defective organization of running service; *c*) difficulties occurring to traffic; *d*) mileages of service and duplicated trains; *e*) driving back, and *f*) other causes.

These particulars will be furnished according to sections of line and direction of traffic, but divided according to type of locomotive.

D. — **Mileages of passenger vehicles.**

Monthly (four weeks after the end of the month).

The mileages will be declared according to categories of trains indicated in paragraph *A*, separately for the directions up and down, with division of the data per sections of line and categories of wagons as mentioned in section No. VIII-*B*.

E. — **Mileages of goods wagons.**

Monthly (four weeks after the end of the month).

The mileages will be set forth according to categories of trains, by sections and directions of traffic. They will be divided up as follows as regards categories of wagons :

1. Covered wagons, normal pattern, excepting wagons with four axles.

2. Inclusive of wagons appropriated to passenger transport.

3. Covered wagons with four axles.

4. Flat, open wagons.

5. High-sided wagons with two axles.

6. High-sided wagons with four axles.

7. Special.

8. Cisterns for the transport of naphtha.

These particulars will be further divided according to mileages loaded and empty, with subdivision into transports fully loaded; separate packages, animals and passengers.

F. — **Mileages of rolling stock conveyed as goods.**

Monthly (four weeks after the end of the month).

These particulars will be divided according to trains, sections of line, direction of traffic conformably to the indications given in paragraphs *C* and *D*, the mileages in axle-versts being stated separately :

1. Locomotives.

2. Tenders.

3. Passenger coaches.

4. Goods wagons.

G. — **Data concerning the technical working of sections of line.**

Daily (forty-eight hours after the end of the day).

The following particulars will be given separately for each section and by directions of traffic :

1. Number of passenger trains (including extraordinary and service trains).

2. Number of military and emigrant trains.

3. Number of other trains, excepting service trains and others having stops outside of stations.

4. Number of service trains and others having stops outside of stations.

For each category of trains there will be set out the number of locomotives and axles of vehicles with their division :

a) Passengers : saloons, classes, mail, prisoners, etc.;

b) Others : 1° with passengers; 2° loaded; 3° empty.

Trains and vehicles (axles) having passed through the whole section will be indicated separately.

NOTE.

1. Classed as military trains will be trains dispatched by request of the military authorities loaded with soldiers and their effects, even in the case of an additional transport of goods, with a view to a better utilization of the traction.

If these trains circulate in accordance with the time-tables of military trains, but without conveying soldiers or their effects, they cannot be classed as military trains. The same remark applies to emigrant trains.

2. Classed as service (administrative) trains will be those which serve for the conveyance of gangs of workmen charged with the maintenance of the permanent way without previous registration, ballast trains, snow trains, etc.

If, on the other hand, the service transports take place with previous registration, these trains will be classed as goods trains.

3. The mileages of trains circulating upon portions of foreign lines, will be taken out by the proprietary line in accordance with the following rules : *a*) the line to which the train belongs reproduces the indication of the foreign section on table No. 8, recording it separately; *b*) in the case above-mentioned, the rolling stock, during its circulation over the foreign

section, will be deducted from the inventory of the home line.

4. *Ad E*-1. — Covered wagons, temporarily appropriated to special transports, will be taken out as covered wagons of normal pattern.

5. *Ad F*-1. — The particulars given in this column will be taken out for the purposes of the technical statistics, independently of the conditions regulating the transport of foreign stock.

XI. — *Commercial work of rolling stock and sections of line.*

A. — Passenger mileages (passenger-versts).

Monthly (nine weeks after the end of the month).

(According to the issue or registration of passenger tickets).

These data are set out separately according to sections and directions of traffic.

The tickets will be divided up by categories :

1. General tariff for adults :
   - *a*) 1st class;
   - *b*) 2nd class,
   - *c*) 3rd class;
   - *d*) 4th class.

2. General tariff, with division according to class for children's fares.

3. General tariff, with division according to priveleged class (including officers' tickets related to the corresponding classes) and carried at military tariff solely.

4. General tariff with division according to class of free tickets.

5. Soldiers sent by detachments (officers separate).

6. Emigrants.

7. Prisoners and their escort.

8. Goods attendants.

B. — Goods mileages.

Monthly (nine weeks after the end of the month).

These particulars will be set out separately for each section of line and direction of traffic.

The mileages will be divided up as follows :

1. Luggage (including the free pood), parcels and postal packets conveyed apart from the mail vans.

2. Emigrants' effects.

3. Commercial goods at quick-freight rates.

4. Commercial goods at slow-freight rates.

5. Military effects.

6. Service transports, effected by service trains with previous registration.

7. Service transports, effected by service trains without registration.

The data of each category will be analysed according to type of vehicle used for the transport, *viz.* :

a) Luggage vans;

b) Covered wagons, normal pattern, excepting wagons with four axles;

c) Covered wagons with four axles;

d) Open, flat wagons;

e) High-sided wagons, with two axles;

f) High-sided wagons, with four axles;

g) Special wagons, excepting cisterns for the conveyance of naphtha;

h) Cisterns for conveyance of naphtha.

There will be recorded, at the same time, by categories *b*, *c*, *d*, *e*, *f* and *g*, the fully-loaded wagons, the separate packages and transports by the piece.

All transports by the piece will be reduced into poods, and their mileages will be set forth in pood-versts.

The mileages of fully-loaded wagons will be set forth in pood-versts, and in wagon-axle-versts; as regards the mileage of service transports, this will be reckoned only in wagon-axle-versts.

NOTE.

Ad A :

1. There will be indicated the mileage of all passengers whose conveyance will be effected by means of every kind of single or return ticket. The time of the run will relate itself to the date of issue of tickets, etc.

2. Monthly, season or annual tickets issued will be taken out separately according to month, class, section of line, and category of traffic.

3. The mileages of passengers and goods will be taken out according to distance of working covered and distance by tariff.

Ad B :

1. Separate packages presented simultaneously by one and the same consignor and for the same address and in quantity sufficient for the complete loading up of a wagon will be reckoned as a full truck-load.

2. Goods traffic will be reckoned, not according to the date of issue of the way-bill, but according to that of the actual dispatch of the goods.

XII. — *Technical operations of stations.*

A. — Number of trains.

Daily (forty-eight hours after the end of the day).

Particulars of the number of trains and of cars forming part of their make-up, by categories, *viz.* :

1. Having passed in transit (received and dispatched);

2. Made up and despatched;

3. Arrived and broken up.

Each category will be subdivided per species of train :

a) Passenger trains of all kinds : fast, express, postal, mixed, etc.;

b) Military;

c) Emigrant;

d) Others, excepting service trains.

These data will be recorded for junction stations, and stations making up and breaking up trains.

The particulars concerning junction stations will include figures for all directions possible; as regards the remaining stations the details will refer only to the two directions : up and down; in the case of the terminus stations, they will be taken out for one direction only.

If the stations make up long-distance trains, the number of trains of this description will be given, the number of wagons forming part of them, and the receiving stations.

B. — Number of cars.

Daily (forty-eight hours after the end of the day).

1. Loaded or prepared for loading.

2. Unloaded, with analysis of each category, as follows :

a) Coaching vehicles;

b) Goods wagons appropriated to transport of men;

c) Goods wagons.

Loaded goods wagons, arrived for the sorting of separate packages, will be mentioned separately, with indication of the number : *a*) arrived for classification, and *b*) despatched after classification.

A record will be further made of the total number of cars at the station at an agreed hour of each day (cars forming part of the make-up of trains being excepted) separately : *a*) coaching vehicles; *b*) wagons appropriated to transport of men; *c*) loaded goods wagons; *d*) empty goods wagons.

An indication will be made at the same time and for each station, of the number of cars according to categories remaining in the station more than one day, with notification of the causes of delay. The particulars will be given per categories of stations conformably with the indications given above.

C. — **Exchange of stock at junction stations.**

Daily (forty-eight hours after the close of the day).

The following data will be recorded regarding exchanges :

1. Compensation in kind (actual exchange).

2. Others.

Each of the categories will be divided up as follows : *a*) number of cars delivered to foreign lines; *b*) number of cars received; *c*) balance of exchange for the day; *d*) compensated without actual exchange (by entries); *e*) statement of car debts at or about the end of the day.

A separate statement will at the same time be made of the number of loaded wagons : covered, open, and others, together with the empty wagons : covered, open, and others.

3. Quantity of goods, received and transmitted for unloading (without exchange of stock) conformably with paragraph 23 of the Russian railway agreement, the data being analysed according to the gauge of the line.

4. Stock transmitted, conveyed as goods : *a*) locomotives, and *b*) wagons.

5. Number of loaded wagons, awaiting despatch towards the end of the day (at midnight).

These particulars will be furnished for all the junction stations, with the exception of the points of exchange, situated at the terminus stations; all the details will be given according to direction of traffic.

D. — **Exchange between railways of special cars.**

Periodically, conformably with indications from the general management of the railways. chiefly on account of difficulties experienced during periods of extraordinary pressure of traffic.

Record will be made of : *a*) classes of cars; *b*) loaded or empty; *c*) forwarded; *d*) received, and *e*) balance of transfer.

XIII. — *Commercial operations of stations.*

A. — **Issue of passenger tickets, application of stamps to temporary tickets, etc.**

Monthly (nine weeks after the end of the month).

Figures will be given, for each station separately, as to the number of passengers, *viz.* :

a) Ordinary and reduced fares : 1° 1st class; 2° 2nd class; 3° 3rd class.

b) Military tariff : 1° 1st class; 2° 2nd class; 3° 3rd class.

c) Emigrant tariff.

d) Prisoners and their escort.

e) Goods attendants.

f) Free : 1° 1st class; 2° 2nd class; 3° 3rd class.

B. — **Despatch and arrival of goods.**

Monthly (nine weeks after the end of the month).

Data, for each station separately, as to the quantity of goods received and despatched :

1. Fast train, on presentation of passenger tickets.

2. Fast train, without presentation of passenger tickets.

3. Postal packets (outside the postal vans).

4. Emigrant transports.

5. Military transports.

6. Goods by quick freight.

7. Goods by slow freight.

8. Service transports, with previous registration.

To categories 1 to 4 will be consigned the number of poods and number of consignments; as regards categories 5 to 8, there will be separate packages, the full truck-loads and number of corresponding loads and consignments.

The full truck-loads of commercial goods by slow-freight will be analysed according to the number of wagons which have served for the transport of the goods by categories, *viz.* :

1. Cereals in sacks.

2. Cereals in bulk.

3. Coal.

4. Building materials.

5. Building timber.

6. Firewood.

7. Mineral oils in cisterns.

8. Ore, fluor spar, and other minerals, building materials excepted.

9. Iron, cast iron, steel (including rails, girders, and other shaped iron goods).

10. Fresh vegetables.

11. Salt.

12. Hay, straw, grass.

13. Cotton, linen, tow, hemp.

14. Cattle and all kinds of live stock, meats, etc.

15. Sugar.

NOTE.

Ad B. — The despatch of goods will be reported not on the issue of the way-bill, but on the date of the actual despatch on the corresponding section of line.

C. — **Despatch and loading per number of wagons.**

Daily (forty-eight hours after the end of the day).

As far as concerns slow-freight goods, a record will be made of :

a) The despatch ;

b) The loading, the following subdivisions being established :

1. Goods awaiting at the warehouses their turn for loading and others.

2. Goods actually brought into the station and handed over by the warehouses and lifts.

3. Goods of 1st and 3rd category, 4th category, and 5th category.

4. Goods to be transported by obligatory routes or to certain destination stations.

5. Goods to be loaded at the stations, at private sidings, and outside the stations

c) Withdrawal from the sender of the right of despatch of goods :

1. Goods admitted into the stations.

2. Goods handed over by the warehouses and lifts.

d) Balance of goods not loaded; number of wagons and succession fixed, with subdivisions as follows :

1. *a*) In the stations; *b*) in established warehouses; *c*) in the stations with temporary installations; *d*) in the stations without temporary installations, and *e*) in warehouses and lifts.

2. *a*) Goods without fixed succession; *b*) 1st-3rd categories; *c*) 4th category, and *d*) 5th category.

3. By points of destination or sections of transport.

4. By duration of time awaiting despatch : one to five days, five to ten days, and so on.

e) Quantity of goods with address altered or carried over from one order of succession to another.

These data and particulars will be recorded by sections, and in cases where the period of waiting turn exceeds five days, by corresponding destination stations.

As regards other goods, a record will be made of the quantity of goods introduced into the stations and loaded :

a) Quick-freight goods; *b*) emigrant transports; *c*) military transports; *d*) service transports.

Independently of the data referred to above, a note will be kept of the quantity of goods delayed in transit for reasons apart from the transport capacity of the system.

NOTE.

Ad c-b-4 and *d*-3. — The analysis of goods according to directions up and down, and by sections of line, will be made in special registers.

D. — **Arriving and unloading.**

Daily (*forty-eight hours after the end of the day*).

a) Goods arrived at destination.

b) Goods unloaded.

c) Goods handed over to consignees.

d) Goods handed over the warehouses.

e) Goods unloaded awaiting their delivery to consignees or their re-despatch to the warehouses.

f) Goods arrived awaiting unloading.

These data will be recorded by sections of line during the periods of great pressure of traffic, when there is reason to anticipate the overcrowding of the stations, for each station separately.

XIV. — *Speed of traffic.*

A. — **Inclusive speed of goods.**

Monthly (*nine weeks after the end of the month*).

The details concerning each line will be given separately for quick-freight and slow-freight, for full truck-loads and separate packages; with analysis according to categories of goods :

a) Transported on the line in transit.

b) Transported on the line in through service : despatched or arrived on the system.

c) Transported on the line in local service.

Independently of this classification, at the request of the general management of the railways subdivisions will be introduced showing results by categories of goods and by direction of traffic for each line.

B. — **Technical speed of trains.**

Monthly (four weeks after the end of the month).

These particulars will be given monthly by sections of line and by directions of traffic, thus :

1. As regards trains despatched without fixed routes, the duration of the run will be recorded. Dividing it by the mileage, one will obtain the average speed : *a*) of the trains; *b*) of the locomotives (locomotives running light given separately); *c*) of wagons loaded and empty. If the trains circulate upon such sections in part without route and in part with route fixed, the average speed will be given for each category of train separately.

2. In the case of trains circulating with fixed routes, the classes of trains will be recorded separately, thus : *a*) fast, express, passenger and postal; *b*) mixed; *c*) military; *d*) emigrant, and *e*) others, and the duration of delays in arrival at the station of destination, will be given separately for each direction.

XV. — *Circulation of : 1° sheets; 2° screens; 3° fittings for military transport; 4° adaptations for cattle transport.*

Periodically, on the request of the general management of the railways (forty-eight hours after the end of the day).

For each category will be indicated : *a*) inventory; *b*) debts remaining due from the preceding day to foreign railways (with mention of the junction stations); *c*) stock received; *d*) stock transmitted, and *e*) stock remaining (balance) towards the end of the day.

The totals of the different periodical abstracts (monthly, quarterly, half-yearly and annual) will be reproduced in the report and accounts of the financial year for each system. The particulars necessary for the official statistics of the ministry of ways of communication (Annex I to the present memorandum) should be presented separately, independently of the data recorded in the annual returns of each system.

SECTION IV : GENERAL

[621 .132.8 & 621 .14] QUESTION XV

MOTOR CAR SERVICES

Porterage, cartage and connecting services by motor car.

Reporter :

All countries. — Mr. J. C. Inglis, general manager, Great Western Railway (Great Britain).

QUESTION XV

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N. B. — Vide also the separate issue (in red cover) No. 17.

[621 .132.8 & 621 .14]

REPORT

By J. C. INGLIS,

GENERAL MANAGER, GREAT WESTERN RAILWAY, ENGLAND.

In reporting upon porterage, cartage and connecting services by motor car, the elementary position has to be recognised that it has become of importance to railway companies to make some provision for the increasingly smaller units of travel and transport, both in respect of passenger and of marchandise traffic, in order :

a) To hold their own against tramway and other similar competition ;
b) To develop new districts, and
c) To secure additional revenue.

It has long been appreciated in the matter of merchandise traffic that the service afforded by railway companies in the collection at the point of origin and delivery at ultimate destination, or alternatively the bridging over of any hiatus in the throughout route by cartage or other similar services, is an essential factor; but in the matter of passenger and parcels traffic these intermediate services, if they may so be called, have not been looked upon with very much favour, although in big centres of population the parcels delivery van has for many years fulfilled its useful functions on similar lines to the goods delivery van, and with proportionate advantage to railway revenue.

Therefore in developing motor car services for dealing with passenger, luggage, and small parcels traffic such railway companies as have adopted the system, have simply applied the principle to this type of traffic which has already been regarded as indispensable in the case of ordinary merchandise.

The development of the motor car in its twofold application to rail and to road transit has placed at the disposal of railway companies a means of extending their activities into new and hitherto undeloped districts, and of protecting their interests against the new competition brought about by the growth of electric tramway systems and motor omnibus and motor lorry services.

The functions of the rail motor and of the road motor vary somewhat, the former being, of course, confined to the railway lines, while the latter primarily affords means of extension from the railway into surrounding territority.

It will, therefore, be convenient to deal separately with the two systems.

1. — Rail motor cars.

So long as transportation by railway always meant the use of a train consisting of a more or less limited number of vehicles, and, of course, a separate engine, working costs were too high to admit, in normal circumstances, of effective competition with tramways or other road vehicles, and the position confronting the railway companies was that while inroads were continually being made into their territories and traffics by tramways, and latterly by motor buses, they were unable to afford competitive or corresponding services under anything like corresponding conditions. The advent of the rail motor helped the railway companies to some extent in this direction, and its usefulness in connection with suburban traffic, as also for various branch purposes, has now been demonstrated over a series of years in many directions.

The great advantage of the rail motor cars absence of detention and occupation of the road at the termini involved under the old arrangements by the running round of the engine. So serious was this occupation in many instances that it imposed an effectual obstacle in the way of the adoption of supplementary train services on main or through lines, and it is a fact that but for the introduction of the rail motor car, many services on through lines now afforded would not be possible.

One of the features in the situation which had to be met was the necessity of driving from either end of the car, but happily mechanical ingenuity soon proved itself equal to this and no disadvantage is now believed to result from this method of working.

On sections of the line where traffic is too heavy to be dealt with by ordinary rail motors and where the congested state of the lines makes the extended use of ordinary trains impossible, what are known as auto trains have been introduced. These auto trains have a small locomotive in the middle of a number of carriages, say four or five, and the locomotive is operated from either end of the train by the driver.

Rail motor cars are at the present time worked on many of the principal English railways, and have been an importance feature in the development of passenger traffic. Incidentally, as they are of one class only, the cars have tended to the

democratisation of travel, and have helped in the solution of the second class problem, especially on country branch lines, where social considerations made the abolition of the second class more than an ordinarily difficult problem.

Another considerable advantage is the possibility of making stops at suitable intermediate points between stations where sufficient population exists to warrant it, although the traffic is too small to justify the erection of a stations of the ordinary type. The provision of short timber platforms is all that is necessary, tickets being issued by the conductor on the car, and new traffic is thus secured at a minimum of cost.

The single unit motor car also affords a more economical means of maintaining branch line and country services where traffic is usually light, than the employment of an engine and coaches.

Conveyance of parcels, etc., by rail motor car. — The steam rail motor car is undoubtedly the nearest approach to the tram-car that steam railways can provide, and the development of suburban travel by their means is now part of the policy of principal railway companies all over the world. In reviewing the work of the rail motor car, in conjunction with the road motor car services which many of the companies have also established, I have been greatly impressed by the possibilities of developing new business in luggage and light goods, perishable produce, parcels and mail matter by the agency of such services.

The machinery set up for the development of passenger travel might be made greater use of than is generally the case to-day for the baggage and parcels business of the railways.

There is a large parcels carrying business between principal cities and towns and surrounding districts which could be efficiently conducted by means of rail motor services. This is a growing business and apart from the railways is provided for by the state parcels post, by tramways and road parcels carrying companies two use motors parcels vans working far out into suburban and rural districts, and by tradesmen's vehicles.

The conveyance of parcels by rail motors between stations does not differ materially from their conveyance by ordinary trains, but the aim should be to extend this business on existing lines by making use of the Halts and the more frequent service — all the railway companies from whom information has been obtained state that the same conditions apply generally to the conveyance of parcels, luggage and mails by rail motor services as apply in the case of ordinary trains.

Parcels traffic at rail-motor halts. — Arrangements have been made by certain of the English railways — including my own company — to deal with parcels traffic at rail-motor halts; at present only a beginning has been made but experiments in this direction have been successful. The fact that at the majority of halts no per-

manent staff is kept, renders it necessary for the parcels to be brought to the cars and handed to the conductor, the booking of the traffic being performed at adjacent stations where a staff is established.

At some halts a man is employed, and there parcels are received and forwarded in the same way as at small stations.

At other places served by halts, agents have been appointed who meet the cars and receive and forward parcels, receiving a small commission for their services. The agent retains received parcels on his premises until they are called for by the consignees, and if not called for on the day of receipt the consignees are advised of their arrival.

The parcels whilst in the rail motors are under the charge of the conductor and are placed either in the luggage body or in the conductor's vestibule, which can be locked up and made inaccessible from the passenger part of the cars.

It is upon lines somewhat of this character that I am of opinion an appreciable parcels traffic by rail motor car might be built up by those railways running cars, and of course the machinery set up for parcels traffic is equally suitable for dealing with luggage, either accompanied by passengers or otherwise, mails, small goods, and miscellaneous traffic such as milk, eggs, butter, poultry, etc.

Accomodation for parcels on rail-cars. — The construction of rail motor-cars generally is of a fairly uniform type in respect of accommodation for luggage and parcel traffic, nearly all the cars being provided with a luggage compartment, and being capable of hauling one or two passenger and goods trailers if necessary for the accommodation of parcels, milk, farm produce, horses, carriages, etc.

Cost of working rail motors. — The average cost of working rail motor cars in Great Britain may be taken as from 7*d.* to 8*d.* per car mile, which is roughly about half the average cost of working ordinary trains. It will be seen from the particulars furnished as per appendix B, that the cost varies a good deal in different parts of the world, and also with the varying types of car, but apart from this, there is the consideration that different railway companies have different methods of preparing their accounts so that the figures given lose their comparative value to some extent.

2. — Road motor-cars.

In cases where outlying districts of some importance have required to be brought into more direct contact with the railway, the motor-omnibus has proved to be the most useful means of accomplishing the desired end.

In the older civilised countries the most important centres, whether agricultural or manufacturing, are now served direct by railway, and those places which have no railway communication have either not sufficient business to justify a railway exten-

sion, or are suffering from the fact that they do not happen to lie on the direct line of route of a main or subsidiary through line.

In such cases where the population is at all considerable, or the district to be served has any potentiality, schemes for light railway provision have naturally suggested themselves, and amongst the useful purposes which the road motor vehicles serve, is that of demonstrating the value from a transportation point of view of various districts which have been represented as only waiting for the advent of a railway to develop and prosper.

While this has been the case in regard to agricultural neighbourhoods more particularly, certain coast towns and seaside resorts, more or less remote from the railway, and formerly only accessible by primitive horsed conveyance have been brought within the range of an easy and comfortable journey, and have secured prosperity, and the possibility of future development, by the establishment of a road motor service in connection with the nearest railway station, while the advantages which the road motor cars have given to farmers and agriculturalists for the more rapid, direct and reliable transportation of small farm products have been unquestionable.

The superior speed of the motor vehicle has also brought remote places of interest into touch with holiday centres served by the railways and by the fact of enabling passengers to travel there and return home the same day a considerable new pleasure traffic has been built up.

Working costs. — In the case of the Great Western Company, the costs vary in different districts according to the character of the roads traversed, and the description of vehicles used, but the over all cost works out to about 9·94*d.* per mile.

The value of the services is, however, necessarily principally contributive.

Turning to another phase of railway work, the motor-van affords a valuable means of extending the area of collection and delivery of parcels traffic and of accelerating these services, as compared with the general use of horsed vehicles.

Comparing the services rendered by the two classes of conveyance the advantages of the motor-parcels-van may be summarised as follows :

1° Quicker delivery to points at the extremities of the collection and delivery area, and extension of such area;

2° Ability to deal with abnormal traffics without necessitating additional assistance. The motor can be worked double shifts if necessary without undue strain;

3° The employment of fast vehicles for the longer distances relieves the horse stud, and enables a better service to be given by them for the short-distance traffic where the motor costs become higher owing to the small mileage.

Parcels collection and delivery in town areas. — For this purpose a small van of about 12 to 16 horse power with a maximum load capacity of 15 cwts. to 1 ton and a

maximum speed of 20 miles per hour seems to be the most suitable, and if sufficient loading and mileage can be obtained to keep it fully employed a much better service can be given than is possible with horsed vehicles, and at a lower cost.

The working costs of a vehicles of this type, taking all modern improvements and advantage of the experience which has been gained, should work out approximately at £4·12 for a 300 mile week.

Appendices to this report give detailed particulars of the Great Western Company's motor car services and the replies given by other railways to questions put to them on the subject.

APPENDIX A.

Rail motor services on Great Western Railway

Description of cars. — The Great Western cars are of two different types, known as "Suburban" and "Branch" respectively, and are of two lengths 59 ft. 6 in. and 70 feet. The first cost of the 59 ft. 6 in. cars is approximately £1,750 each and of the 70 feet cars £2,000.

The "Suburban" cars are designed to serve districts of an urban character, where large populations confined within comparatively limited areas have to be provided for, and the "Branch" cars are used on country branch lines.

The cars are powerful enough to haul a couple of passenger trailers or several horse boxes or goods vehicles, but in practice it is not considered desirable to attach more than one of the former, or three to four of the latter class of vehicle, although it is sometimes done. The cars will take two trailers on the level.

SUBURBAN CARS.

The underframes are of steel and are carried at one end by the engine bogie, which is suspension hung, while at the vestibule end some of the cars have suspension hung bogies and other bolster bogies.

The cars can be driven from either end and are divided into compartments as follows :.

59 ft. 6 in. cars.

Suburban. — Motor, 14 feet long; smoking, 14 ft. 9 in. long; non-smoking, 26 ft. 7 in. long, and vestibule, 4 ft. 10 in. long. 50 seats, one class.

Branch. — Motor, 14 feet long; luggage or smoking, 6 ft. 3 ½ in. long; passenger, 32 ft. 9 in. long, and vestibule, 4 ft. 9 in. long. 49 seats, one class.

70 feet cars.

Suburban. — Motor, 14 feet long; smoking, 14 ft. 4 in. long; non-smoking, 35 ft. 7 in. long, and vestibule. 4 ft. 9 in. long. 64 seats, one class.

Branch. — Motor, 14 feet long; smoking or luggage, 6 ft. 3 ½ in. long; passenger, 43 ft. 3 in. long, and vestibule, 4 ft. 9 in. long. 63 seats, one class.

The cars are arranged with cross seats of the "walkover" type in the middle, and longitudinal seats, arranged in sets of three, at each end.

Access to the passenger compartment is obtained by means of side doors at the motor end, and sliding doors from the vestibube to the compartment.

Hinged steps are provided on the majority of the cars to enable passengers to enter and alight at the rail level at places where the traffic does not justify the construction of raised platforms.

The lighting is by ordinary or 20 candle power incandescent gas lamps, the gas being stored in cylinders attached to the underframe.

Hand and vacuum brakes, which can be operated from either end of the vehicles, are fitted to each bogie.

Motor. — The cars are driven by a steam motor, using coal as fuel, the capacity of the bunker being 21 cwts.

The cylinders are 12 × 16 inches fixed horizontally on frame of bogie. They drive on to the trailing pairs of wheels which are coupled to the leading pair. The wheels are 3 ft. 6 in. diameter on earlier and 4 feet diameter on later cars. The cylinders have balanced slide valves and the valve motion is of the Walschaert type. The tractive efforts are 7,806 and 6,912 lb. respectively.

Boiler. — Steam is supplied by a vertical boiler with cone top, 4 ft. 6 in. diameter, fitted with 462 tubes $^1/_{18}$ inch diameter.

Height of boiler	9 ft. 6 in.
Working pressure	160 lb.
Heating surface, tubes	605· 9 square feet.
Fire box	46·75 — —
Total	652·65 square feet.
Grate area	11·54 — —

A water tank of 450 gallons capacity is attached to the underframe. The weights on the bogie are :

59 ft. 6 in. cars.

Driving bogie	25 tons 4 cwts.
Trailing bogie	13 — 12 —
Total	38 tons 16 cwts.

70 feet cars.

Driving bogie	26 tons 18 cwts.
Trailing bogie	16 — 5 —
Total	43 tons 3 cwts.

Taking ordinary conditions a motor car without trailer runs about 30 miles, including stops, without taking water,

A later type of car has recently been constructed, the lengths of the compartments being as follows :

70 feet cars.

Motor	14 ft. 0 in.	Luggage	7 ft. 10 in.
Smoking	11 ft. 6 in.	Non-smoking	26 ft. 9 $^1/_2$ in. (61 seats).
Driver's	3 ft. 9 in.	Vestibule	3 ft. 9 in. (1 class).

Fig. 1. — Great Western Railway. — 70 feet rail motor car with centre doors and luggage compartment.

Fig. 2. — Great Western Railway. — Rail motor car with compartment for luggage.

Fig. 2. — Great Western Railway. — Rail motor car with accommodation for passengers desiring to smoke. — 70 feet long.

Fig. 5. — Great Western Railway. — Four-car motor train composed of four 70 feet trailers with covered auto-engine, for heavy suburban work.

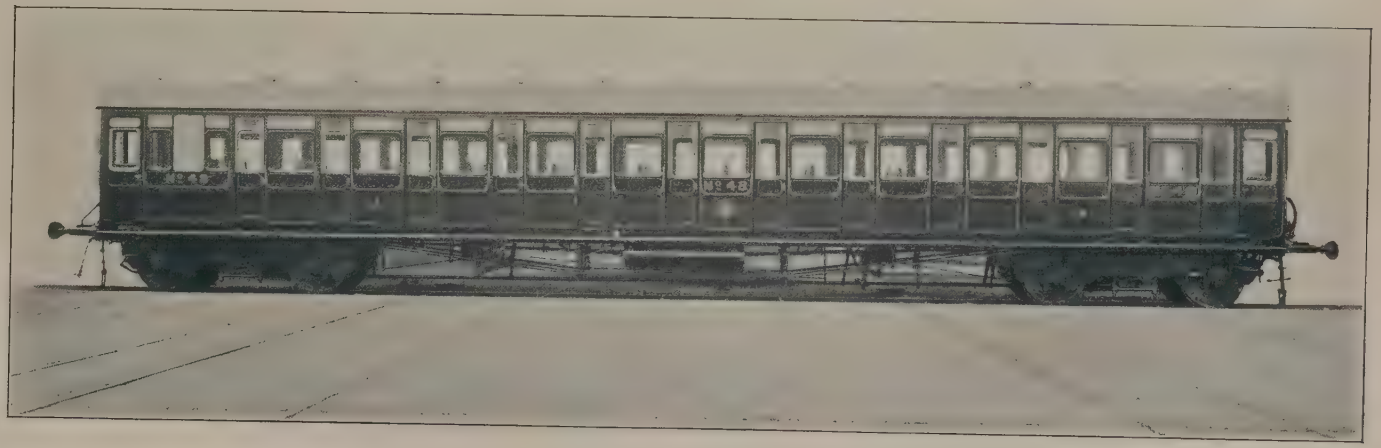


Fig. 6. — Great Western Railway. — Motor trailer with side doors which can be operated from either end of car.

Fig. 7. — Great Western Railway. — 70 feet motor trailer with small engine capable of being driven from either end.

59 f. 6 in. cars.

Motor	14 ft. 0 in.	Luggage	6 ft. 7 1/2 in.
Smoking	8 ft. 6 in.	Non-Smoking	20 ft. 6 in. (45 seats).
Driver's	3 ft. 9 in.	Vestibule	3 ft. 9 in. (1 class).

These cars weigh 43 to 45 tons and 39 tons respectively.

Some illustrations of the various types in use accompany this report.

The company to-day work 35 separate rail motor car services ten of which have been introduced to replace ordinary train services, and the remainder have been put on to provide for the local traffic on new lines, or to augment ordinary train services with a view to cultivating local traffic and to feed trunk line services. Upwards of nine million passengers are conveyed annually by these car services, about 2 1/2 million car miles being run per annum. The cars are booked to run at overall speeds of from 20 to 30 miles per hour.

Cost of working. — The cost of working (exclusive of depreciation and interest) during the year 1908 was 8*d.* per car mile, divisible as under:

Wages	2·72*d.*
Fuel	1·54*d.*
Lubrication	0·18*d.*
Maintenance and miscellaneous expenses	3·56*d.*

Halts. — There are about 140 halts. The cost of constructing them varies fron £150 to £400 according to the character of the halt and buildings, length and height of platforms and nature of site. The majority are provided with shelters of corrugated iron of the standard size 20 × 7 feet with seats. A photograph of one of these halts accompanies this report. At a few important places, the platforms are extended to 350 or 400 feet to accommodate ordinary trains and a booking hall and office of light construction and other necessary accommodation is provided. The cost of these is of course proportionately greater. These halts are developed as the traffic requirements necessitate and so as to accommodate ordinary trains.

Conveyance of mails. — Mail bags are at present conveyed by some of the cars being brought to and taken from them by the Post Office staff. The bags whilst on the motors are under the care of the conductor; generally speaking they are stowed in the conductor's vestibule or in the luggage body, but where the halts are numerous and the absence of the conductor from his car may be frequent, patent hooks are fixed in the vestibule to which the bags are attached and the appliance is locked.

Motor trains. — As a variation from the general arrangement of cars, two rail motor cars and two passenger trailers have been fitted with close couplings, and are designed to run in pairs, each pair consisting of a 70 feet motor car and a 70 feet trailer, an open gangway being provided between the cars, which can be attended to by one conductor. The train seats 143 passengers, 80 in the trailer and 63 in the motor car. This train may be driven from either end and two such sets may be coupled to form a four vehicle train, and when this is done, the engines of the motor cars are placed at the ends of the train for general working convenience.

A multiple train unit has also been designed, consisting of a covered engine of the $\frac{0-6-0}{T}$ type, and two close coupled trailer cars at either end, and the train can be driven from either

end compartments, or from the engine footplate. The train accommodates 312 passengers in all, smoking and luggage accommodation is provided and communication between the smoking and non-smoking porttons is established by means of a doorway. Electrical commutation is provided from the ends of the train for the convenience of the driver and conductors.

When four trailer cars are not required, two cars at either end of the engine may be detached.

Auto-trains. — Auto-trains, which consist of a small locomotive with one or more trailer cars attached are used on branch and local lines in several districts. The engines are of the $\frac{0-4-2}{T}$ and $\frac{0-6-0}{T}$ types, and have been fitted with additional regulator gear, enabling them to be driven either from the engine footplate or from the driver's compartment in the trailer.

Horse boxes, carriage trucks, milk vans, etc., are attached to these auto-trains as circumstances require.

A 70 feet trailer car has also been put into service of a similar pattern to those in use on the Illinois Central Railroad of America which are used for suburban traffic in Chicago. This car has ten side sliding doors which can be close simultaneously by means of a lever in the conductor's compartment at either end, but open independently by hand.

The seats in this car are arranged in the centre crosswise with gangways at either side, giving free access and egress at the side doors.

Figures shewing the various types of car accompanying this report :

Figure 1. . . . 70 feet rail motor car with centre doors and luggage compartment;
- - 2. . . . Rail motor car with compartment for luggage;
— 3. . . . 70 feet rail motor car with accomodation for passenger desiring to smoke ;
— 4. . . . 70 feet motor car and 70 feet trailer coupled, capable of being driven from either end;
— 5. . . . Four-car motor train composed of four 70 feet trailers with covered auto-engine, for heavy suburban work ;
— 6. . . . Motor trailer with side doors which can be operated from either end of car ;
— 7. . . . 70 feet motor trailer with small engine capable of being driven from either end.

APPENDIX B.

Rail motor-cars.

ANSWERS TO ENQUIRIES MADE.

If rail motor-car services in operation, say if self-contained locomotive and carriages, and give description of cars.

Great Central. — Yes, three such services. Engine : four coupled outside cylinders 12 inches diameter in 16 inches stroke, " Walschaerts " valve gear-forms front bogie of coach. Coach frame of ordinary trussed British type with other end carried on 4-wheeled bogie, swing link suspension to each end. Body with longitudinal seats and middle entrance. Luggage compartment at engine end. Driver's compartment at other end.

Lancashire & Yorkshire. — Yes. Engine : outside cylinders, 12 inches in 16 inches stroke, " Walschaerts " valve-gear. Water in tanks in such a position as to give greater adhesive weight on driving wheels. Car body 47 ft. 6 in. long, divided into three compartments. A third class compartment to seat 56 passengers and driver's compartment at rear end. Transverse seats; operated from either end (see fig. 8).

Midland. — Yes. Four-wheel coupled bogie steam motor carriage. Operated either end.

North Eastern. — Yes, two cars. Engine : four cylinder horizontal petrol motor. Cylinders 8 $^1/_2$ inches diameter in 10 inches stroke. Car of ordinary bogie saloon type 52 feet over headstocks. Dividod into three compartments. Forward end contains petrol motor and generator, passenger portion and gangway, rear compartment contains machinery for operating car from either end.

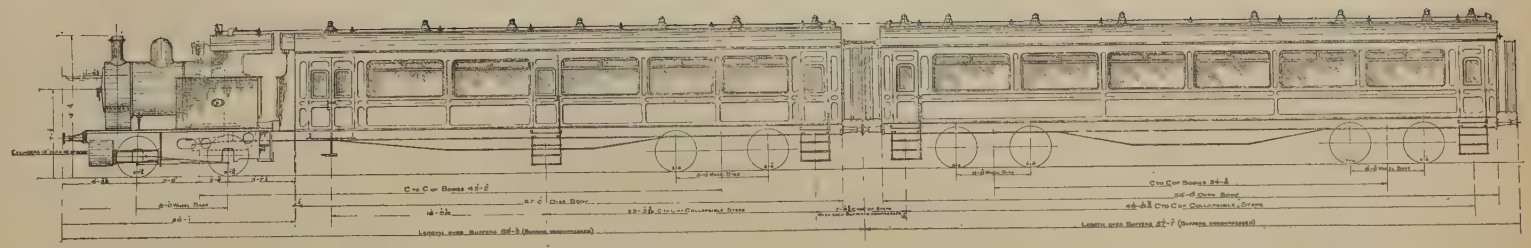
South Australian. — Yes. Steam motor carriage. Engine cylinders, 6 $^1/_2$ inches diameter in 10 inches stroke; 180 lb. working pressure. Some cars can be driven from either end (see fig. 9).

Great Indian Peninsula. — Yes. One car running on short local service. Engine : driving wheels, 3 ft. 5 in. diameter. Cylinders, 9 inches diameter in 15 inches stroke. Steel underframe, teak wood. Regulator handles at either end.

Madras & Southern Mahratta. — Yes. Engine : four wheels coupled. Steel frame. Teak timber body. Operated either end.

North Western India. — Yes. Engine : outside cylinders, 9 inches diameter in 14 inches stroke; single driver; wheels, 3 ft. 3 in. diameter, valve motion. Weight on driving wheels, 14·5 tons. Car; luggage compartment; third class, 70 passengers; second class, 5 passengers; first class, 5 passengers. Operated either end.

Central South African. — Yes. Engine : four wheels coupled, frame of ordinary plate construction. Car, one end carried on ordinary carriage bogie of strong construction while other



Weight empty.	14 t. 6 c. 0 q.	13 t. 4 c. 2 q.	14 t. 10 c. 3 q.	13 t. 2 c. 0 q.
Weight in working order.	16 t. 2 c. 0 q.	16 t. 12 c. 0 q.	14 t. 16 c. 0 q.	
	To seat 56 passengers.			To seat 72 passengers.

Weight of coach empty	42 t. 1 c. 1 q.	Heating surface : tubes	455 square feet.	Boiler pressure	180 lb. per square inch.
— in working order	47 t. 10 c. 0 q.	— — : firebox	54 — —	Grate area	9·4 square feet.
— of coach and trailer empty	68 t. 5 c. 1 q.			Tank capacity	550 gallons.
— in working order (exclusive of passengers)	73 t. 14 c. 0 q.	Heating surface : total	509 square feet.	Quantity of coal	1 ton.

Fig. 8. — Lancashire & Yorkshire steam motor rail coach and trailer.

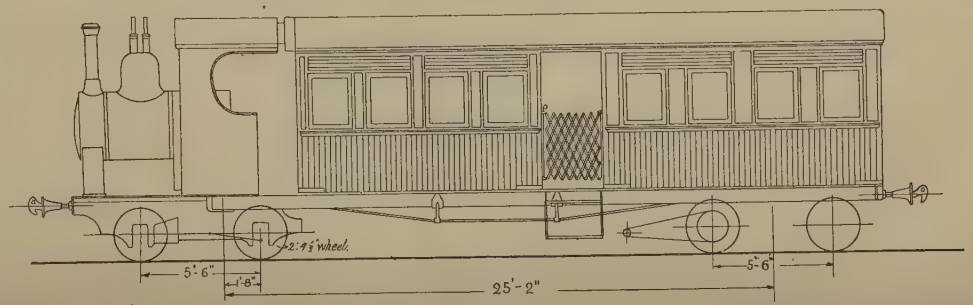


Fig. 9. — South Australian Railways. — Steam motor carriage No. 1. 3 ft. 6 in. gauge. — 180 lb. working pressure; cylinders, 6 1/2 inch diameter × 10 inch stroke.

end rests on the engine frame, the latter therefore carries the weight of its own engine and boiler and also part of the weight of the car. Operated either end. Four compartments, *viz.* : luggage compartment next to engine; compartment to accommodate, 24 passengers; compartment to accommodate, 24 passengers; driver's compartment.

New York, New Jersey & Western Railroad (Erie Railroad Company). — Yes, gasoline, 200 horse-power, steel frame, steel body, cannot be operated either end.

Buenos Ayres Great Southern. — Yes. Engine : outside cylinders, 9 inches diameter in 15 inches stroke; " Walschaerts " valve gear, operated either end of car. Car : Pullman type, first class, second class and luggage compartments.

Austrian State Railways. — Yes. Steam motor cars. Komarck system, upright boiler : steam motor cars, Serpollet system, normal Serpollet boiler and twin engine. Benzolin motor car. Daimler with vertical four cylinder benzin motor with mechanical power, transmission by cog wheels.

In every case the wagon body and engine are connected in one piece with the frame. Can be operated either end.

Hungarian State Railways. — Yes. Steam motor cars, 35 horse-power and 50 horse-power engine. Ganz & C°. Total length, 38 feet. 9 second and 24 third class passengers, or 38 third-class passengers. Cannot be operated either end, but cars under delivery will be capable of being so operated.

Paris, Lyons & Mediterranean. — Two types of motor cars :

First type : The generator and motor are carried on the chassis of the same carriage, seating capacity of cars varying from 36 to 55 passengers. Cannot be operated either end.

Second type : The generator and motor are carried by a special truck. The body of the coach is separate from this truck, but it is so arranged that it can be coupled to any motor truck. Seating capacity of cars 12 first class, 29 third class. 12 passengers on platform at end. Luggage compartment.

French State Railways. — Yes. Up to present trials only have been made. Engine of compound type, four cylinders arranged in pairs which act on front axle by means of articulated chain. Body. Front platform for driver and boiler. Luggage body. Second and third classes, and a rear platform with standing room. Can only run in one direction, have to be turned.

Italian State Railways. — Yes. Combined locomotive and van. Engine vertical boiler, two cylinder motors 11 diameter in 15 3/4 inches stroke. Body consists of three compartments : 1° engine and boiler; 2° postal packages; 2° luggage. Length, 27 ft. 10 in.; width, 9 ft. 8 in. Must run with engine in front.

Swiss Federal Railways. — Yes. Ordinary trains in one district supplemented by a motor car. Double axle wagon of which one axle is driven by a four cylinder benzine motor of the Daimler type. Can be driven in either direction.

Cost of working per car mile

Great Central. — 4·682*d.*

Midland. — 7·67*d.*

North Eastern. — 5·299*d.*

South Australian. — 10*d.*

Great Indian Peninsula. — 6·5*d.*

North Western India. — 9*d.*

Central South African. — 11·8*d.*

New York, New Jersey & Western. — 1*s.* 3*d.*

Buenos Ayres Great Southern. — 2*s.* 3·5*d.*

Austrian State Railways. — Komarck, steam : 3·07*d.*; Serpollet, steam : 2·95*d.*; Daimler, benzolin : 3·02*d.*

Hungarian State Railways. — de Dion Bouton, steam : 5·18*d.*; Stoltz, steam : 8·26*d.*; benzine, electric : 4·04*d.*

Arad Railways, Hungary. — Daimler, petrol : 2·98*d.*; Ganz steam : 2·87*d.*; de Dion petrol electric, 20 horse-power : 2·76*d.*; 70 horse-power : 3·58*d.*

Are trailers attached for heavy traffic?

Great Central. — Yes, but not regularly, two bogie coaches is maximum number that can be hauled up 1 in 100 at 20 mile per hour.

Lancashire & Yorkshire. — Yes for passengers.

Midland. — Yes, one car only is allowed to be hauled.

North Eastern. — No.

South Australian. — Yes, one vehicle only being used.

Great Indian Peninsula. — No, car run up to 30 mile per hour.

Madras & Southern Mahratta. — Yes, two cars maximum which can be hauled.

North Western India. — Yes, two bogie third class coach only.

Central South African. — No.

New York, New Jersey, & Western. — No.

Buenos Ayres Great Southern. — No, when traffic is heavy train engine and ordinary carriages are substituted. Maximum weight that can be hauled is 120 tons or three Pullman Cars.

Austrian State Railways. — Komarck Motors can draw two or at most three trailers.

Hungarian State Railways. — Motor Cars travel alone or with one to three trailers.

Paris, Lyons & Mediterranean. — Yes, one or two trailers.

French State Railways. — Yes, one trailer usually attached.

Italian State Railways. — Yes. Passenger service made by trailers. Five ordinary or axle trailers can be taken. Motor must always be in front.

Swiss Federal Railways. — No.

Accommodation provided by cars.

Great Central. — First and third class smoking and non-smoking compartments.

Lancashire & Yorkshire. — All third class to seat 56 passengers. Accommodation for luggage in a limited degree, and for non-smokers.

Midland. — First and third class. Smoking and non-smoking compartments. Accomodation for luggage.

North Eastern. — Only one class and ono compartment. Accommodation for luggage.

South Australian. — First and second class non-smoking. Accommodation for luggage.

Great Indian Peninsula. — First and third class. Accomodation for luggage.

Madras & Southern Mahratta. — Accommodation is for more than one class. Accommodation for luggage.

North Western India. — First (5 passengers), second (5 passengers), third (70 passengers). Accommodation for luggage.

Central South African. — 28 firsts, 24 second class passengers. One car provides for 48 passengers one class only. Accommodation for luggage.

Buenos Ayres Great Southern. — 28 firsts, 24 second class passengers. Smoking allowed both compartments. Accommodation for luggage.

Austrian State Railways. — Every motor car train carries two classes. Motor car itself only adapted for one. All cars provided with luggage carriers.

Hungarian State Railways. — Second class, and third class 24 passengers, or 38 third class passengers. Smoking permitter on trailers only. Accommodation for luggage and mails.

Paris, Lyons & Mediterranean. — Two classes, no special compartments for smoking. Accommodation for baggage.

French State Railways. — Two classes of passengers, second and third. Seating, 24, standing, 12. No special compartments for smoking. Accommodation for luggage.

Italian State Railways. — No passengers, only luggage and postal packages. Passenger service made by trailers.

Swiss Federal Railways. — Third class only. Smoking allowed on car platform. Accommodation for luggage.

Is luggage and parcels traffic deals with at halts?

Great Central. — Yes.

Lancashire & Yorkshire. — No.

Midland. — Only passengers' personal luggage.

North Eastern. — No.

South Australian. — Yes, by traffic porter who sees that the proper freight charge is made. A covered van used for goods traffic at stations.

Madras & Southern Mahratta. — Yes.

Central South African. — Yes.

New York, New Jersey & Western. — No.

Buenos Ayres Great Southern. — No halts.

Austrian State Railways. — Over a section of line luggage and goods are not conveyed by motor car. On some sections luggage is dealt with, but goods only at places where facilities are provided. On a section where goods are not conveyed by motor car an ordinary goods truck is attached for this purpose.

Hungarian State Railways. — No.

Paris, Lyons & Mediterranean. — Yes. By conductors and porters.

Italian State Railways. — Only where there is the necessary accommodation.

Swiss Federal Railways. — No.

Wurttenberg State Railways. — Yes, when necessary accommodation is provided. When this is not provided luggage is taken on train and booked at first available station.

GENERAL REMARKS.

Development of rail motor on Arad railway. — The Arad and Csanader joint railways of Hungary seem to have made considerable strides with petrol-driven rail motor-cars. In 1903, the management found it necessary to provide additional rolling stock, and for the reason, amongst others, that the construction of the line was of a somewhat light nature, it was determined to work the system by running frequent small units instead of the small number of complete train which had been used formerly.

After experiments with one petrol and four steam cars, the company decided to adopt a system of combined petrol and electric drive, and a number of cars worked on this principle were ordered. Two types were introduced — one of 20 to 30 horse-power for slow traffic and one of 70 horse-power for the fast trains.

The 20 to 30 horse-power cars run at a speed of about 20 miles per hour-full speed being attained in approximately two minutes from starting — and carry sufficient petrol for a run of 360 kilometres. The 70 horse-power cars attain a speed of from 35 to 40 miles per hour in from 1 to 1 $^1/_2$ minute from starting.

Union Pacific Railroad. — The Union Pacific Railroad of America, starting in 1905 with one rail motor car, have now in service a number of motor-cars driven by the internal combustion engines, which have been constructed by the company in their shops at Omaha. Considerable success has attended these services from the commencement. They are fitted with vertical six-cylinder water cooled engines, arranged transversely in the frame, the drive coming practically direct through a metal to metal clutch, change-speed gear, and thence by means of a single heavy chain to the driving axle. Both accumulator and magneto ignitions are fitted, and the

engine is started up by means of compressed air. As regards costs of operation, these seem to vary greatly in the United States, but so far as the Union Pacific is concerned it is understood that they average from 6*d*. to 7 ½ *d*. a mile, the unsettled cost of fuel and density of traffic affecting the matter greatly.

Paknam Railway Company. — The Paknam Railway Company of Siam have adopted a type of Petrol Rail Motor Car for the conveyance of passenger and goods traffic. On the trials, the vehicle carried a load equal to 40 passengers and negotiated an upward gradient of 1 in 40, with a 9 chain curve at 15 miles per hour. The fuel may be either petroleum (kerosene) or petrol spirit. Sufficient fuel is carried for a total run of about 300 miles.

Chicago Rock Island & Pacific Railroad. — The Chicago Rock Island & Pacific of America have adopted a steam motor car of steel constrction throughout the vehicle being of the self-contained type containing engine room, baggage room and passenger compartment, having seating accomodation for 40 persons, with lavatory attached. During trials this car shewed high speed capabilities, on several runs speeds of 60 miles per hour being obtained.

APPENDIX C.

Road motor services on Great Western Railway.

Type of cars. — The Great Western Company of England operate 29 road motor car services or the conveyance of passengers, parcels and goods traffic, and employ altogether 112 cars of various types, all driven by petrol engines (except one steam wagon, and two steam tractors used for heavy goods work, and two electric lorries).

The bodies of the cars are being standardized into four types, *viz.* :

See figure 10. . . . 1° Double deck omnibuses accomodating 36 passengers.
— — 11. . . . 2° Single deck omnibuses accomodating 20 passengers and 15 cwts. of parcels and luggage.
— — 12. . . . 3° Observation or char-a-banc cars. accommodating 30 passengers.
— — 13. . . . 4° Composite car accomodating 20 passengers and 1 ton of parcels or goods. When not requiredfor this purpose, the goods compartment is available for smokers.
— — 14. . . . 5° Double deck omnibuses, with luggage compartment, accomodating 32 passengers and 10 cwts. of parcels or luggage.

The weight of the cars unladen varies from 3 1/4 to 4 1/2 tons according to the type of body, and they are all fitted with solid rubber tyres purchased from approved makers.

Working arrangements. — The cars run in connection with the train service, and are times dat an inclusive speed of 8 to 10 miles per hour. The mileage per car per day ranges from 40 to 80 miles. A spare car (or cars) is kept to ensures reliability of service and to provide for heavy traffics.

Fares, etc. — Passenger fares are arranged on the basis of 1 1/2 *d.* per mile, but this has occasionally to be varied to meet special local circumstances. Season tickets are not issued, but with the view of encouraging frequency of travel, books of tickets are sold at reduced rates. In special cases, cheap return tickets are issued in connection with railway journeys to golfers and fishermen, and for market purposes. The bell-punch system is employed, except in the case of through rail and road bookings, when card tickets of the usual railway pattern are used.

Through ordinary tourist or excursion bookings by rail and road motor car are in operation to a number of seaside places and country holiday resorts.

Full fares are charged for all seats occupied, whether by children or adults.

Reliability. — As the staff have gained experience in their work the reliability of the cars has improved. The following figures show the results achieved at some of the principal centres during the half-year ended December 1908 :

CENTRE.	Number of failures.	Car mileage.	Miles per failure.
A.	Nil.	31,667	...
B.	Nil.	14,555	...
C.	1	20,162	20,162

Fig. 10. — Great Western Railway. — 20 horse-power 2 ton Milnes-Daimler chassis, fitted with standard double-deck body. Accommodation 16 passengers inside, 18 on top deck, and 2 on front seat. Maximum speed : 12 miles per hour.

Fig. 11. — Great Western Railway. — 20 horse-power 2 ton Milnes-Daimler chassis, fitted with single-deck body. Accommodation 20 passengers, and 15 cwt. luggage. Speed : 12 miles per hour.

Fig. 12. — Great Western Railway. — 28 horse-power Durkopp chassis, fitted with observation body. Accommodation 27 passengers. Maximum speed : 12 miles per hour.

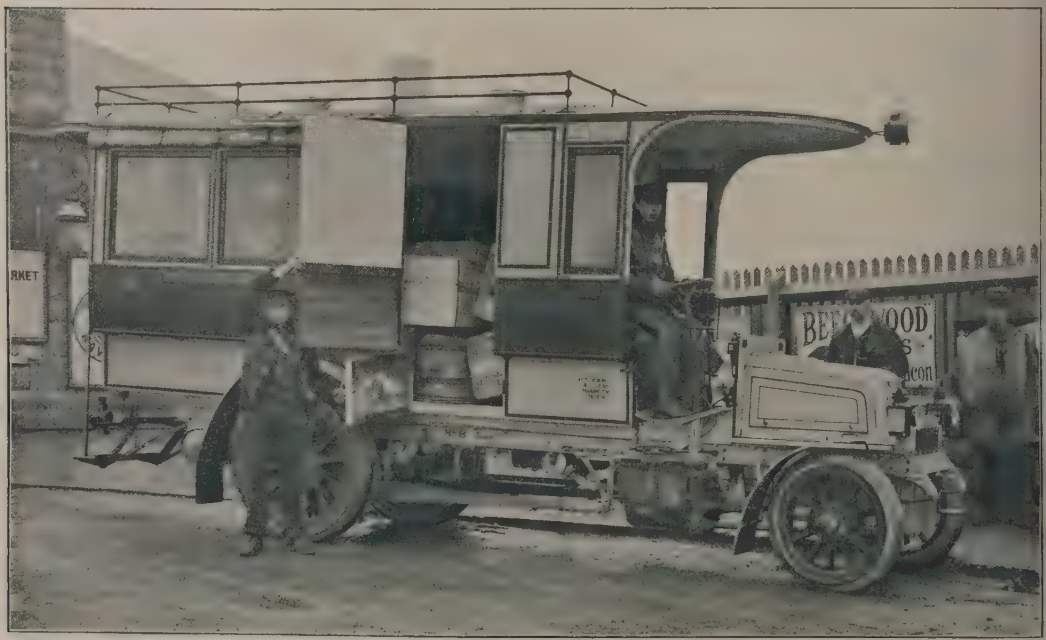


Fig. 13. — Great Western Railway. — 20 horse-power 2 ton Milnes-Daimler chassis, fitted with composite goods and passenger body. Accommodation 12 passengers, and about one ton in goods compartment and 15 cwts. on roof. Maximum speed : 12 miles per hour.

Fig. 14. — Great Western Railway. — 30 horse-power Milnes-Daimler chassis, fitted with special double-deck body, with luggage compartment. Accommodation 32 passengers, and about 10-15 cwt. goods. Maximum speed : 12 miles per hour.

Fig. 15. — Great Western Railway. — Standard road motor car shed, with office for driver (on right) and stores behind office.

Fig. 16. — Great Western Railway. — Electric goods lorry, driven by storage batteries. Capacity, 2 ton.

Fig. 17. — Great Western Railway. — Typical rail motor halt.

Receipts and expences. — The receipts per car mile for the half-year ended December 1908 amounted to 1*s.* 0·34*d.* and the working expenses per car mile were 9·94*d.* including maintenance but excluding renewal.

	Per car mile.
Wages	3*d.*
Lighting and lubrication	0·38*d.*
Traffic materials, etc.	0·10*d.*
Motive power	1·16*d.*
Maintenance, cars	2·38*d.*
— tyres	1·80*d.*
Miscellaneous	1·12*d.*
Total.	9·94*d.*

A number of cars have been running for over five years, and are still working as economically and efficiently as at first. Even if they should be superseded for passenger work by more up-to-date vehicles they can still be used for many years in the capacity of goods lorries.

Development of traffic. — With regard to the contributive value of road motor services to the railway, some special records have been taken from time to time of the amount of traffic brought to and taken from the railway stations by the cars, and the results on some typical services are shown over :

SERVICE.	Total number of passengers carried.	Percentage of rail passengers.
A.	952	55·98
B.	446	73·99
C.	473	62·79
D.	392	73·46

SERVICE.	Parcels.	Percentage rails-borne parcels.
A.	25	92
B.	179	72·62
C.	188	100
D.	102	100

The extent to which traffic can be developed by improved facilities is indicated by the following instance :

Passengers conveyed by subsidized coach from April 1905 to April 1906 (Coach service on 14 April 1906)	6,191
Passengers conveyed by car from April 1906 to April 1907	18,220
Increase.	12,029
	= 194 per cent.

Parcels, etc., by road car. — Parcels, luggage and light goods traffic is conveyed by all the

road motor services operated by the Great Western Company, with the exception of three urban services where the route of the car is covered by the ordinary parcels and goods collection and delivery arrangements.

Parcels, etc., rates and arrangements. — Passengers' luggage. — Small hand luggage under the passenger's own care is carried free. Other luggage not exceeding 1 centweight each package, which can be conveyed without inconvenience, is charged for a the following rates :

2*d.* per package up to	56 lb.	Up to a distance of 6 miles.
4*d.* — —	112 —	
4*d.* — —	56 —	Up to a distance of 12 —
6*d.* — —	112 —	
6*d.* — —	56 —	For distance over 12 —
8*d.* — —	112 —	

Luggage in advance. — Passengers' luggage in advance subject to the usual conditions, is conveyed at charges of 6*d.* and 9*d.* per package, according to distance in addition to the charges for conveyance by rail.

Parcels. — Parcels and small packages not exceeding 1 centweight each package are conveyed at the following charges :

Not exceeding 7 lb. in weight	2*d.*	For distances up to 12 miles.
— 28 — —	3*d.*	
— 56 — —	4*d.*	
— 112 — —	6*d.*	
— 7 — —	3*d.*	For distances over 12 miles.
— 28 — —	4*d.*	
— 56 — —	6*d.*	
— 112 — —	8*d*	

Bicycles and perambulators which can be carried without inconvenience, are conveyed at a charge of 1*s.* each, and folding mail carts at a charge of 6*d.* each.

Newspapers. — Single newspapers are conveyed by the cars at a charge of $^1/_2 d.$ each.

Rates for goods traffic. — Consignments of goods traffic not exceeding 5 cwts. are charged for at the rate of 9*d.* per cwt. (minimum charge 4*d.* per package) and for consignments exceeding 5 cwts. the charge is 6*d.* per cwt. (minimum charge 3*s.*), provided the latter can be split up, if necessary, and carried on the cars at the company's convenience.

All charges have to be prepaid.

In addition to these arrangements, parcels traffic is booked through between places served by the cars and all Great Western Railway Stations, the local motor charges given above generally being added to the rail charges. Rail-borne traffic carried by the cars to two or three important places beyond the rail head, is, however, charged through to destination at the railway rates.

Luggage, parcels, etc., are usually carried on the roofs of single-decked cars, which are designed to take weights of 15 cwts. (see figs. 11 and 13). A special composite passenger and goods car (see fig. 13) is in use on some roads where this traffic is above the average. Cars of this type are also used for heavy mails. In the case of services worked by double-deck cars, accommodation is provided either by removing one or two of the top seats, or by the provision of a luggage compartment, as shown in figure 14.

The parcels agents, who are usually small shop-keepers, are remunerated by the payment of commission on the following scale :

Parcels up to 28 lb.	$\frac{1}{2}d.$ per parcel.
— over 28 lb.	$1d.$ —

The conductor of the car is responsible for the traffic while in transit, and for handling it over to the station master or agent, as the case may be, at destination. Parcels may be accepted by the conductor *en route*, and in such cases he collects the charge and fills up, in duplicate, a way-bill, one copy of which is kept by him and handed in at the station with the cash collected, while the other is given to the sender as a receipt.

The charges on rail-borne traffic are dealt with by the station in connection with which the road cars work.

The charges on passengers' luggage, bicycles, etc., are collected on the cars, and a ticket drawn in duplicate, one copy being handed to the passenger, and the other retained by the conductor, and checked with cash paid in by him.

Mails. — Postal matter is conveyed by the cars on eight different routes, by arrangement with postal authorities, who pay an agreed sum per annum in each case. The mails are in the charge of the motor conductor.

Development of parcels traffic — The following statements show the percentage of parcels-traffic to passenger-traffic on some of the road-motor services, and the progressive growth of the parcels business :

SERVICE.	Proportion of parcel traffic to passenger traffic.	SERVICE.	Proportion of parcel traffic to passenger traffic.
A.	22·5 per cent.	C.	19·4 per cent.
B.	31·5 —	D.	15·1 —

Total parcels and goods traffic in year :

SERVICE.	1905	1906	1907	1908
	£	£	£	£
A.	86	111	136	160
B	Service not established.		141	192
C.	...	...	124	197
D.	...	50	89	92
E.	...	179	203	223
F.	67	92	91	118

No separate accounts are kept as to the cost of dealing with parcels traffic as distinct from the other classes of traffic, but as the same establishment of cars and staff would be employed, and the same mileage run for passenger purposes alone, the only expense incurred is in the payment of commission to agents and the small amount of clerical and porterage work necessary at the station from and to which the cars run.

APPENDIX D.

Road motor-cars.

ANSWERS TO ENQUIRIES MADE.

Are road motors in use, and what type?

Great Eastern. — Twenty-one petrol motors in use in country districts for conveyance of passengers, parcels and light goods. Carrying capacity 30 to 36 passengers, and in certain cases about 1 ton of luggage and parcels. Twelve of these built in company's own works.

Lancashire & Yorkshire. — Only two petrol motor omnibuses employed. Not sufficient experience yet obtained to give information of any value.

Midland. — Two petrol motor omnibuses in use conveying parcels, as well as passengers.

North Eastern. — Sixty-seven petrol omnibuses with accommodation for passengers and parcels in use.

Southern of France. — A summer service of three cars carrying passengers, luggage and parcels is run by a contractor under agreement with the company. This has replaced a former horsed vehicle service.

Bavarian State Railways. — Fifty-eight petrol driven passenger cars and 32 passenger car trailers in use in country districts. Motor vans also used for conveying mails between station and post office in Munich. All petrol vehicles.

What arrangements are in force for dealing with parcels, luggage, etc, traffic by motor in country districts?

Great Eastern. — Charges for parcels : 14 lbs., 4*d.*; 28 lbs., 6*d.*; 112 lbs., 9*d.*
Maximum weight 1 cwt., except in certain cases where it is restricted to 14 lb. Inflammable traffic not conveyed.
No through booking arrangements exist and special scale of rates in force.
In some cars a special compartment for goods provided. Small and luggage carried free.
Other luggage charged 4*d.* up to 56 lb.; 6*d.* up to 112 lb. Maximum weight 1 cwt.

Midland. — Cars convey parcels as required. No other particulars furnished.

North Eastern. — Charges from 2*d.* to 4*d.* according to distance. Maximum weight 1 cwt. Fish, inflammable articles and bulky packages not carried. Hand luggage carried free. Other luggage 3*d.* per package. Maximum weight 1 cwt.
Through bookings in force to limited extent.

Southern of France. — Contractor establishes Receiving Offices at points required by company. Parcels delivered but not collected. Not extra charge for delivery. Charges according to mileage scale. Parcels booked through luggage up to 30 kilograms (66 lbs.) per passenger carried free. Excess luggage charged on mileage scale.

Mails carried in special van provided for purpose.

Bavarian State Railway. — Depots provided at which parcels, etc., are collected and delivered. Traffic is taken to and from depots by senders and consignees themselves.

Charges : 80 per cent of the customary freight of the place. No maximum weight.

What arrangements are in force for conveyance of postal packages by road motor.

Great Eastern. — Special arrangement in force for conveyance of one bag daily by one of the services.

North Eastern. — About three bags per day conveyed. Payment 4*s.* per week.

Bavarian State Railway. — Services are combined mail, passenger, and luggage. Value articles carried in lockers under seats. Conductor, who is in postal service, responsable for mails.

Wurtemberg State Railway. — Postal administration run motor mail vans.

What arrangements in force for dealing with parcels traffic by motor vehicle in urban areas?

Midland. — Four petrol driven parcel vans in use. Two cylinder, horse-power 12 to 16. Capacity 1 to 2 tons.

North Eastern. — Three motor vans (Durkopp) in use in Newcastle.

Bavarian State Railway. — Four Daimler motor vans in use in Munich. Horse-power 11 to 16. Speed 20-28 kilometres (12·4-17·4 miles) per hour. Capacity, $^3/_4$ to 1 ton.

Have replaced 16 drivers and 17 horses.

Heavy goods work in town areas.

Great Central. — Five 5-ton steam and petrol motor lorries, all approximately 35 horse-power with speed of 5 miles per hour in use. Have replaced three 2-horse teams in London, and two 2-horse and one 1-horse teams in provinces.

North Eastern. — Six steam wagons in use. Capacity 5 tons, speed 5 miles per hour.

Steam wagons compare unfavourably with horses when full loads not obtained. Petrol vehicles on short trial found cheaper than horses.

Orleans Railway. — Two steam wagons in use in Paris. Speed 8 to 12 kilometres (5 to 7·5 miles) per hour, load 6 tons. Cost per ton : steam wagons, $^2/_6$ *d.* horse wagons, $^2/_{10}$ *d.*

Italian State Railways. — Twenty-five St. Pancras steam wagons in use. Speed, 7 $^1/_2$ miles per hour; capacity, 5 tons; trailer, 3 tons.

Working costs.

RAILWAY.	Wages.	Fuel.	Lubrication.	Tyres.	Maintenance.	Per cent.	Total.
Great Central.							*Per ton.*
Steam wagon in London	1s. 3·61d.	4·9d.	1d.	...	19 p. c.	20 p. c.	...
Steam wagon in provinces	10s. 21d.	1·76d.	0·83d.	...	13 p. c.	20 p. c.	...
Petrol wagon in London	1s. 3d.	4·12d.	2d.	...	7 p. c.	20 p. c.	...
Petrol wagon in provinces	1s. 1·49d	5·71d.	1·09d.	...	9 p. c.	20 p. c.	...
Midland.							*Per mile*
Parcels vans Milnes Daimler 2 tons	4s. 95 t.	1·61d.	0·21d.	2d.	2·47d.	...	11·24d.
Lacre 24 cwt.	2s. 66d.	1·45d.	0·09d.	0·93d.	0·75d.	...	5·93d.
Halley 1 ton	3s. 55d.	2·05d.	0·18d.	0·66d.	0·67d.	...	7·11d.
Wolseley 18 horse power bus	2s.	1·46d.	0 07d.	1·19d.	...	...	...
Maudslay do.	2s.	1·89d.	0·07d.	1·08d.	...	...	...
Great Eastern.							
Omnibuses	2s. 88d.	1·62d.	0·32 t.	1·95d.	3·13d.	...	9·90d.
North Eastern	Average 1s. 2·20d. all vehicles.						
Orleans.							
Steam wagons in Paris	...	...	...	...	...	...	8·75d.
Italian State Railways.							
Steam wagons	3s.	2·39d.	4d.	1·43d.	...	...	...
Bavarian State Railways.							*Per kilometre.*
Passenger cars	1s.2d.	7·3d.	2d.	1d.	10 p. c. of first cost p. a.	...	...
Goods cars	1s. 2d.	7·7d.	0·2d.	1d.	...	...	...
Parcel vans	1s. 14d.	0·33d.	0·12d.	0·5d.	0·8d.	...	...

SECTIONAL DISCUSSION

Meeting held on 9 July 1910 (morning).

MR. COLSON, IN THE CHAIR.

The President. (In French.) — Mr. Coventry has kindly undertaken to give a summary of Mr. Inglis's report to the meeting.

Mr. Coventry, Great Western Railway. — I have been entrusted, in the absence of Mr. Inglis, with the task of summarising his report upon motor car services. In his report, Mr. Inglis points out the importance of the railway companies making provision for the transport of increasingly smaller units of travel and transport over short distances, in order :

1° To hold their own against tramways and other similar competition;

2° To develop new districts;

3° To secure additional revenue.

In regard to merchandise traffic, the service of collection from point of origin and delivery at destination has long been undertaken by railway companies within a comparatively short radius of their stations. For passenger traffic even these intermediate services have in the past not been thought to be of much importance, and no attempt has been made to collect either passenger or merchandise traffic from towns or villages situated at a distance from the line, but still within the sphere of influence of the railway. This traffic will have to be encouraged in the future and rail and road motors seem to be the best means of dealing with it.

These two types of motor cars, of course, serve different purposes; the rail motor car can only be used on the railway lines, whilst the other is run on the ordinary roads and streets.

These distinctions being understood, the report first deals with rail motor cars, which have also been mentioned in another section of the Congress.

The Great Western Railway brought these motors into use, having found that the cost of trains was too high to enable them to compete with the tramways. Thanks to the rail motor car, the Great Western Railway has been able to meet this competition with success.

The motor cars have three great advantages over the complete trains with separate engines :

1° They do away with, or entail less use of, transfer roads at terminal stations. Indeed, a larger number of new trains from both main line and branch line, can now use the big stations, the running lines of which are no longer encumbered by local trains;

2° Only one class being provided, the cars have helped in the solution of the second class problem, a very real difficulty on country branch lines owing to social considerations;

3° Another advantage of these rail motor cars is that it is possible to arrange for

*

stops at points where sufficient population exists but where traffic is too small to justify the erection of a station of the ordinary type. For rail motor cars it is sufficient to erect a small wooden platform, similar to figure 17 in the report.

The results obtained by the Great Western Railway with rail motor cars prove that they provide a means of cheap and efficient transport on lines of secondary importance, the traffic of which is not large enough to warrant the use of complete trains with separate engines.

As regards the cost of working these rail motor cars, the results obtained by the Great Western Railway shew that these work out at from 7*d*. to 8*d*. per car-mile (45 to 51 centimes per car-kilometre), which is about one half the cost of working an ordinary train. From appendix *B* of the report, where the replies of the different companies to the question of cost are given, it will be seen that this varies considerably in different parts of the world; owing to the different methods of preparing accounts it is impossible to make an exact comparison.

In cases where outlying districts of some importance have required to be brought into more direct contact with the railway, the motor omnibus has proved to be the most useful means of accomplishing the desired end.

The Great Western Railway use road motor cars on twenty-nine routes, and carry passengers, luggage and goods. One hundred and twelve vehicles of different types are used. Appendix *C* gives details together with illustrations of the different types of cars belonging to this railway company.

Running in connection with the nearest railway station, these cars often prove that it is only necessary to adopt this form of transport to assure rapid growth and prosperity to the district served. These services naturally result in an increase of traffic on the railways running them. They are also of great importance in agricultural districts as they enable farmers to transport their produce rapidly and surely to the markets of the towns.

The superior speed of the motor car has enabled small places to be brought into closer touch with important centres, so as to stimulate the traffic between the two points and bring about the development of the small towns. In appendix *C*, statistical information is given shewing how quickly these motor service have developed as feeders to the Great Western Railway.

In regard to the cost of working, this varies with the nature of the route covered and the type of vehicle used. Speaking generally, however, it has been found by the Great Western Railway that it is about 9·94*d*. per mile (64 centimes per kilometre).

The value of these road motor cars depends entirely on the quantity of traffic necessary to justify their introduction. They are used largely for the purposes of collection and delivery of traffic. Compared with horsed vehicles, road motor cars shew the three following advantages as shewn on page 8 of the report (1):

1° Quicker delivery to points at the extremities of the collection and delivery area, and extension of such area;

2° Possibility of dealing with exceptional traffic without necessitating an in-

(1) Vide *Bulletin of the Railway Congress*, number of December, 1909, p. 1741.

crease in the number of cars. The motor car can when necessary work double shifts, without excessive strain;

3° The employment of fast vehicles for the long distances relieves the horses, which can give a better service for short distance traffic, where the motor cost would be higher on account of the short mileage.

The Great Western Railway has obtained the best results, so far as town service is concerned, with a small motor van of 16 to 20 horse power with a loading capacity of 15 cwts. and a maximum speed of 20 miles per hour. The working cost of this van comes out at about £4.12*s*. for a weekly run of 300 miles.

I would add that the replies the reporter has received from other companies on the subject of the use of motor cars for services of collection and delivery are very brief and of little use. It would seem that other railways have not interested themselves in this means of transport so much as the Great Western Railway. Those who have experimented with motor traction appear to have obtained less satisfactory results, due I believe, to their types being too large and heavy and also to the motor vehicle not having been employed to the best advantage; that is, it is used on the same routes as the old horsed vehicles, when it would be more advantageously employed, especially the smaller type, on other and longer routes.

For myself, I am convinced that this means of transport, especially the smaller type, will be more extensively used in future. I feel sure that if sufficient loads and mileage can be obtained for them, motor vans of the type mentioned in the report and illustrated in the photographs have a great future before them.

The President. (In French.) — Before beginning the discussion of motor-car services, I wish to inform the meeting that the question of motor vehicles running on rails has already been discussed at length by the 2nd, 3rd and 5th sections, meeting jointly; and they adopted the following conclusions :

1° Automotor cars can be used in certain cases for economic services, in order to facilitate local communication at a moderate outlay, provided that the traffic conditions lend themselves to the organization of trains, carrying a regular traffic or at least one which only varies rarely and but little, that the line is an easy one and that the goods traffic can be carried conveniently and completely on separate trains;

2° The power of the motors of the automotor cars should present a certain margin beyond the ordinary work, so that it is possible to cope with variations of the traffic within certain ascertained limits;

3° It would be desirable to make it possible to utilize the car independently of the motor by having either separate motor trucks, or some other device making it possible to remove and replace the mechanical part easily;

4° From the point of view of economy of staff, that is to say, having only one traction agent, accumulator or petrol cars seem the most suitable. It would be desirable that the investigations should be continued in order to ensure simple design and easy and inexpensive maintenance;

5° As regards steam cars, it would be desirable to reduce to a minimum the care required for the boiler and in particular to improve the semi-automatic feeding of the grate or to improve the methods of using liquid fuel;

6° It would be desirable to recommend the investigation of small locomotives able to replace automotor cars, with the advantage of greater independence. The luggage-van

locomotives, or the motor luggage-vans, represent an immediate solution, which it seems can be suitably applied in certain cases.

It seems that after such a full discussion and after such detailed conclusions have been adopted, we can hardly take up this subject again; and what we have to consider is the question of motor cars running on highways either for connecting up places not reached by the railway or for cartage purposes.

Mr. Guerreiro, *vice-president*. (In French.) — In the first place, I wish to commend the report of our colleague Mr. Inglis, concerning road motor cars.

Owing to the reasons just given by the President, the question of rail motor cars cannot come before us, as it has already been discussed by three other sections. We must accordingly limit ourselves to the subject of road motor cars, which is, moreover, of great interest; and Mr. Inglis was more competent than anybody else to deal with this here.

In his report he gives a summary of all the information he has obtained from the different companies, and above all from that which he himself manages and which has such well-organized services.

He has not drafted any conclusions, but at the beginning of his report he sets forth the advantages of motor car services and I propose to you that we should consider that part of his report as conclusions. I merely give you the wording :

" The Railway Congress recognizes that it has become of importance to railway companies to make the necessary provision for the transport of passengers and merchandise in the case of increasingly smaller distances and increasingly smaller quantities, in order :

" *a*) To hold their own against tramway and other similar competition;

" *b*) To develop new districts;

" *c*) To secure additional revenue."

To this I add another clause as follows :

" *d*) To operate the postal service."

You know that on the Continent the postal service is operated by the railways; and therefore I think it necessary to add the clause to the conclusions.

That is the proposal I have the honour to submit to you.

Sir Chas. J. Owens, London & South Western Railway. — I will commence by thanking the reporter for the information with which he has furnished us on the subject of motor vehicles. With the two honourable members who have already spoken, I agree that the question which this section has to consider is more particularly that relating to road motors. I myself am especially familiar with goods working, and I have noticed that the capacity of transport by motor vehicle is not always proportional to the motive power. When motor vehicles contain heavy loads it frequently happens that the unloading takes two or three hours and during the whole of this time the motors are at a standstill, and earn nothing, whereas in the case of horse vehicles, the animals can be detached during the unloading and utilized in other ways. From this point of view therefore, motor traction is inferior to horse traction.

If the motor could be separated from the vehicle and used for another purpose, a great advantage in favour of motor traction would be gained. The London

& South Western Company has found this objection to be less in the case of the delivery of single packages than in the delivery of such consignments as occupy a considerable time. The question is far from complete elucidation and it is to be hoped that fresh light will be thrown upon it by discussion.

As concerns the transport of passengers by road motor vehicles, my company has organized three different services.

By the first service, passengers were carried to and from the New Forest, but at the end of a few months the service was abandoned as the company was put to a loss.

The second service was designed to serve a rural district. This likewise was not a financial success — in fact it put the company to a slight loss, but it was felt that the service should be continued since it brought certain indirect advantages which compensated the loss.

The third service has been established under very favourable conditions to connect two parallel lines of railway distant about 12 miles one from the other, and passing through a very frequented district.

This service has supplied an easy means of transit between the localities traversed and the two railway stations thus connected. The vehicles are largely used, are much liked by the residents, while the financial results have been satisfactory.

A point not mentioned by Mr. Inglis in his report, and one which is particularly interesting to me, is the lapse of time in which, in the opinion of the Great Western Company, it is necessary to scrap the vehicles.

I feel that if the working of a service of road motor vehicles is to be efficient, the vehicles should be scrapped in six years.

This mode of transit is still in its infancy. It requires to be perfected and simplified before it can give practical results and be put to more general use. I think it is a question for the future and that it might well figure in the programme of a future session of the Congress.

Mr. C. Peter Clark, Permanent Commission of the Congress. — In my capacity as reporter on question XII, I desire to contribute a few remarks on this subject.

Thirteen years ago I had charge of a railway steam motor which is still in existence.

This car was unpopular with the trainmen because of the decreased size of crew required. It also caused considerable track trouble because of the heavy weight on the engine end which weighed 35 tons (the total weight on eight wheels was 57 tons). It was, finally, withdrawn from service on that light track, as the extra track maintenance offset the saving in running expense.

I believe that the substitution of gasoline for coal is sure to make great improvements, as it is possible to obtain far greater tractive power with the same weight, or the same power with much less weight.

We are now building a number of these gasoline cars in the United States and in 1909 there were forty-five of them in service, some seating 105 passengers.

The General Electric Company has recently produced a similar car furnished with a gasoline driven dynamo which applies the electric power direct to the axles, so as to avoid the transmission by chain.

The company are now building twenty of these cars, a number of which have already been sold.

The railway with which I have been connected for some time was obliged to use terminals in the city of Buffalo belonging to other companies at a great expense, and consideration has been given to the plan of highway delivery by motor truck. There are a number of suitable motor trucks operating in that vicinity, some of which handle 10 tons at 5 miles an hour; some carry 8 tons and draw a trailer carrying 5 tons more.

These motor wagons run from 12 to 15 miles an hour and appear, when the distance to be covered is several miles, to be cheaper than horses.

Mr. Coventry. — Mr. Owens has spoken of the depreciation of motor cars and observed that this should be calculated on a term of six years. I can mention a case in which a vehicle has been in use for seven years and is still working and in good condition.

Mr. Harahan, Erie Railroad, United State. — The company which I represent owns two motor cars of the type described by Mr. Clark, which are used in replacing trains previously operated by steam. These motor cars are giving satisfaction generally, but in the use of them we have thoroughly developed the fact that the principal essential for their success is in the proper care in their maintenance. They should be located as near to shops as is practicable. They should have a man running them who is capable of operating machinery successfully so as to keep it in repair, otherwise they are liable to failure which is a source of much expense, not only in the cost of repairs but in the loss of business brought about by such irregularity.

So far as the use of automobiles in America, for the purposes which this discussion treats of, is concerned, our conditions are radically different compared with those in Europe. In America, the railroad companies, as a general rule, do not deliver freight to business houses or to private houses; the delivery of freight to the railroads by the consignor, and the delivery from the railroad to the consignee is effected generally by the consignor and consignee, respectively, or by independent trucking companies. However, the express companies in America perform a service somewhat similar to that which is herein discussed, they collecting and delivering with their own vehicles that character of merchandise which they transport. Their shipments, however, are transported exclusively on passenger trains or upon special trains which are run exclusively for express business, and which are of higher grade than even what is termed as fast freight trains. As a general proposition, however, the express companies deliver their business only in the larger towns, and make no attempt to gather freight in from the highways outside of the towns. So far as the United States is concerned, it is a fact that in the greater part of the country the highways are not capable of being used for the purpose of heavy motor cars at all seasons of the year on account of their bad condition. In the older part of the country where it was necessary to have highways before railroads were built, the highways compare favourably with those of other countries, but in the newer section of the country the highways are very bad, which fact is recognized by a sentiment which is growing in the country looking towards the

improvement of road conditions. In many places our railroads were really pioneers and often were built instead of highways, and now the effort in improving highways is to improve those acting as feeders to our railroads.

Mr. Bloch, Orleans Railway. (In French.) — Seeing the present state of the question of motor cars on roads, it would be inadvisable to adopt any conclusions; but it would be useful if everybody would give information about such services, so as to give the members of the Congress data on which to base their opinions.

With this object in view I am going, as my contribution, to tell you the results of the experiments made by the Orleans Company, as regards mountain services.

The company has organized three motor car services, on the central plateau where the network of railways is of very large mesh; these services connect up places which are 30, 40 and even 50 kilometres (18·6, 25 and even 31 miles) away from the railway.

They have now been running two or three years with satisfactory results; in summer of course, for in winter these mountain roads are deep in snow.

Thus we have a service from Aurillac to Entraygues *viâ* Mont Salvy; another from Aurillac to Mur de Barrez and a third from Neussargues to Pierreford *viâ* Ussel.

Those services are on very difficult roads, and this will give you some idea of them; the Entraygues service starts at a point 600 metres (1,968 feet) above sea-level; then it goes up to 800 (2,625 feet), then down again to 528 (1,732 feet) and then up again to 900 metres (2,953 feet).

Another service starts at a point 800 metres (2,625 feet) above sea-level, then goes down to 500 (1,640 feet) and then up again to 1,000 metres (3,280 feet).

The third starts at a point 600 metres (1,968 feet) above sea-level, and then goes up to 770 and to 900 metres (up to 2,526 and to 2,953 feet.

As regards the former services, which run on mediocre roads, it did not from the start seem possible to adopt cars of the English type, with rubber tires.

The cars used for these services run on iron tires; with such tires petrol motors are unsuitable because of the jolting, and accordingly Purrey steam cars were adopted.

These services have been running regularly during the last two or three years and there have been very few breakdowns.

Travellers are pleased, for we have saved two hours in a journey taking five hours.

We have compared the cost of these services with that of the Great Western Railway services and we arrived at 62 centimes per car-kilometre (9·58*d*. per car-mile), while the Great Western found 64 centimes per car-kilometre (9·89*d*. per car-mile). The staff expenditure is nearly the same, but what is curious is that the sum of the traction costs and tire costs is the same for both services.

As regards the average cost of passengers, it is much the same, about 10 centimes per kilometre (1·54*d*. per mile).

The experiment thus appears to be satisfactory, and the traffic is growing.

We have also organized some short-distance services, but these as a rule have failed because motor-car traction costs more than horse traction, without any compensating advantages, owing to the shortness of the runs.

In conclusion, I do not think that the question is ripe yet, and no definite solution can be drawn from the experiments hitherto made. That is why I have suggested to Mr. Guerreiro to tone down his conclusions a little and we have jointly agreed to propose the following conclusions :

" The Railway Congress recognizes that it is of interest to improve, by means of road motor car services, the relations between stations and places distant from the railways, thus facilitating the conveyance of passengers, and the transport of goods and of mails.

" The number of road motor car services is, however, at present still too limited, and the experiments made are not yet sufficiently advanced, to make it at present possible to draw any precise conclusions as to the establishment and operation of such services.

" The 4th section proposes that this question should be kept on the agenda for the next meeting of the Congress."

Mr. Balaban, Rumanian State Railway. (In French.) — It seems that the conclusions proposed apply more particularly to railways managed by companies, but I think that a reservation is necessary as regards railways operated by the State. Railway-transport enterprises have in view both public and private interests, but these two objects are not of equal importance to a State administration and to a company.

A State administration must in the first place consider the general interest; it must ask itself whether the enterprise it is going to start is made necessary by that interest. Where competition exists between different transport companies, it is advisable to leave private initiative a free hand. The State should not interfere, but there are exceptions to this rule, as for instance in the case mentioned by Mr. Bloch, when the roads are so difficult or so bad that no transport service exists.

In that case there is a local interest mixed up with the general interest, and this double interest compels the State to act, either by subsidizing certain private services, or by organizing a transport service, so as to stimulate private initiative. Although it is sometimes of interest to companies to start competition with other companies, yet that is not, in most cases, so with the State. I agree with Mr. Bloch when he says in his conclusions that the question is not ripe enough to enable us to adopt any very precise conclusions. I even think it would be as well to introduce a reservation and to say in the proposed conclusions that the Congress recognizes the advisability of improving road motor car services when the general interest requires this to be done.

Mr. Bloch. (In French.) — It would only be necessary to add a word to the first clause and say :

" The Railway Congress recognizes that it is of general interest to improve, by means of road motor car services, etc."

Mr. Balaban. (In French.) — That is no longer a reservation.

Mr. Piéron, French Northern Railway. (In French.) — I propose to say :

" The Congress recognizes the utility of improving, in the general interest, by means of road motor car services, etc."

The President. (In French.) — Before I put the conclusions to the vote, the section will perhaps be interested in receiving some information about a legal provision, in force in France, which affects the subject under discussion.

The French government, as you know, gives subsidies to the minor railways which we call "railways of local interest", concessions of which are granted by the departments who also give subsidies. These minor railways generally connect smaller places with the main railroads.

Some ten years ago, it was thought that expense out of proportion to the interets involved could be avoided by giving certain departments the opportunity of organizing motor car services instead of such minor railways. The authors of this proposal did not imagine that the motor car could replace the railway in places where the latter is useful. But they thought that the motor car could be very useful as a means of ascertaining what traffic there might be in any district, as the vehicles could readily be shifted elsewhere if the results led to the abandonment of the service, either if there was not sufficient traffic to justify its maintenance, or if on the contrary, the traffic developed sufficiently to make a railway necessary. The French government, in order to prevent the construction of an excessive number of minor railways, of doubtful advantage, had inserted a clause in that law, under which subsidies could be given to motor car services, at a period when the problem was not yet solved from the technical point of view, so as to show the parties interested that an economic solution could be offered to them, in the no doubt near future. The law was not much of a success; it only received one or two applications.

Last year the law reduced still further the obligations imposed on those services. It had been specified that they must be able to carry 10 tons; this amount was reduced to 2 tons. These facilities, plus the progress made in automobilism, seem to have led to some enterprises.

It does not, however, seem that there is any fear of motor car services competing with the railway, when it is a question of interconnecting places of minor importance; for even when helped by the State, private initiative shows but a moderate readiness to establish regular services in the country.

I will now put to the vote the conclusions proposed, together with Mr. Balaban's amendment. They run as follows :

" The Congress recognizes the utility of improving, in the general interest, the communications between railway stations and outlying districts, by means of road motor car services, so as to facilitate passenger, goods and mail traffic.

" The number of such road motor car services is, however, as yet too limited and the trials made have not yet advanced far enough to make it at present possible to draw any definite conclusions concerning the establishment and operation of such services.

" The Congress proposes to keep the question on the list of agenda for the next session of the Congress."

— Adopted.

*

DISCUSSION AT THE GENERAL MEETING

Meeting held on 14 July, 1910 (afternoon).

MR. P. WEISSENBACH, PRESIDENT, IN THE CHAIR.

GENERAL SECRETARY : MR. L. WEISSENBRUCH.

FIRST ASSISTANT GENERAL SECRETARY : MR. MÜRSET.

SECOND ASSISTANT GENERAL SECRETARY : DR. A. BONZON.

Mr. Bloch, *principal secretary of the 4th section*, read the

Report of the 4th section.

(See *Journal de la huitième session*, No. 7, p. 5.)

" In the absence of Mr. Inglis, Mr. COVENTRY (*Great Western Railway*) gave particulars of this subject.

" The report drawn up by Mr. Inglis included two parts : one concerning the rail motor cars, and in accordance with a suggestion made by the President, this special subject was discussed by the 2nd, 3rd and 5th sections at a joint meeting ; the other concerned road motor-car services and was discussed by the 4th section.

" In connection with the latter point, Mr. Inglis noted their utility for communication between railways and outlying districts, and described the interesting experiments carried out on the Great Western Railway with numerous and important services. He also recommended the use of light vans for parcels collection and delivery in towns,

" In the ensuing discussion, Mr. GUERREIRO (*Permanent Commission of the Congress*) proposed that the statements contained in the report itself should be adopted as conclusions; Sir Charles OWENS (*London & South Western Railway*) disputed the advantage of motor car road services, at least in the case of goods in large quantities, and thought that as regarded passenger services this was a question of kind depending on individual circumstances; Messrs. C. Peter CLARK (*Permanent Commission of the Congress*) and HARAHAN (*Erie Railroad*) considered more especially the case of motor cars on rails, foreign to the 4th section. Mr. Harahan however remarked that in the United States express companies attended to the collection and delivery of goods and that passenger motor car services on roads would be

impossible owing to the bad condition of roads generally, except in the eastern parts of the country. Mr. Bloch (*Orleans Railway*) gave an account of the road motor car services operated by the Orleans Railway Company in Auvergne, and of the results obtained, and thought that in the present state of knowledge the question had to remain an open one. He proposed to the section to adopt the conclusions accepted by Mr. Guerreiro in place of his own and which took Messrs. Balaban' (*Rumanian State Railway*) and Piéron's (*French Northern Railway*) observations into consideration.

" The President, before putting these to the vote, mentioned the nearly fruitless attempts so far made, by the French government, to establish such motor car services. After these remarks the 4th section then adopted the following conclusions."

The President. — The following are the

CONCLUSIONS.

" The Congress recognizes the utility " of improving, in the general interest, " the communications between railway " stations and outlying districts, by means " of road motor car services, so as to facilitate passenger, goods and mail traffic.

" The number of such road motor car " services is however as yet too limited " and the trials made have not yet advanced far enough to make it at present " possible to draw any definite conclusions concerning the establishment and " the operation of such services.

" The Congress proposes to keep the " question on the list of agenda for the " next session of the Congress."

— These conclusions were confirmed by the general meeting.

APPENDIX

Corrigenda to the report.

Page XV-36 of the separate issue No. 17 and of the *Proceedings* (page 1768 of the *Bulletin* of December, 1909), line 2 of the 2nd column, *instead of :* " 10*s.* 21*d.* ", *read :* " 10·21*d.* "

Page XV-36 (page 1768 of the *Bulletin*), lines 5 to 10 and 12 to 15 of the same column, *instead of :* " 4*s.* 95*d.*, 2*s.* 66*d.*, 3*s.* 55*d.*, 2*s.*, 2*s.* 88*d.*, 3*s.*, 1*s.* 2*d.*, 1*s.* 2*d.* and 1*s.* 14*d.* ", *read :* " 4·95*d.*, 2·66*d.*, 3·55*d.*, 2*d.*, 2*d.*, 2·88*d.*, 3*d.*, 1·2*d.*, 1·2*d.* and 1·14*d.* "

SECTION IV : GENERAL

[625 .244 & 656 .235.7] QUESTION XVI

PERISHABLE GOODS

Suitable measures for developing the traffic in perishables : packing, refrigerator vans, appliances for keeping temperature constant, etc.

Reporters :

Countries using the English language. — Mr. J. M. Culp, vice-president, Southern Railway.

Other countries. — Mr. R. Bloch, chief engineer, assistant traffic manager of the Orleans Railway, France.

QUESTION XVI

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N. B. — Vide also the separate issues (in red cover) Nos. 16 and 54.

[625 .244 & 656 .235 .7]

REPORT N° 1

(Countries using the English language

By J. M. CULP,
VICE-PRESIDENT, SOUTHERN RAILWAY.

INTRODUCTION.

It is of prime necessity that, in order that freight traffic of transportation lines shall be preserved and increased, all commodities transported shall be delivered at points of destination, or consumption, in as nearly perfect condition as may be practicable. But commodities forming the list of perishables are distinguished by the fact that practically the entire list contributes directly to the support, or amelioration, of human life, and it is of the very highest importance that this particular form of traffic shall be delivered to consumer with the least possible deterioration.

A disposition to full co-operation on the part of the producer must be assumed and relied upon. The highest state of perfection in the transportation of perishable property is wasted effort in the absence of proper preparation for its shipment, and proper facilities for its receipt and distribution at destination. The carrier has the same ground for expecting the profit-taking shipper of perishable freight to adequately prepare and deliver his goods for transportation, as exists in the case of the shipper of ordinary merchandise. Hence, the province of the carrier with relation to the duty of the shipper and receiver, in this respect, must be more suggestive than otherwise and will be so treated below.

*

As self-interest prompts the producer of perishable freight to provide the best methods to secure good condition of his property when delivered to the carrier, so the carrier is presumed to employ every ordinary precaution for receiving and transporting : *e. g.*, adequate loading platforms, preservation of cleanliness in cars by prohibiting their loading with deleterious freight, cleansing and testing of refrigeration apparatus, etc. This discussion will therefore deal mainly with the care of the property en route.

It is a safe assertion that intelligent experimentation in the handling of perishable freight has proceeded with all the carriers by rail to a degree commensurate with the difference between the requirements for handling such freight, and the requirements for handling ordinary property. With the increase of the non-producing population, has grown the necessity for commensurate increase and regularity of supply, which has been met no less in the cases of fresh meats, fruits and vegetables, than in the cases of building material, fuel, clothing and staple articles of food. Obviously, the volume of traffic in certain classes of perishable freight, which are more or less luxurious to the large mass of consumers will never equal the volume of traffic in staple articles of consumption : but carriers recognize the desirability of bringing producer and consumer together, and are sparing no proper effort to this end.

Barometric and thermal conditions are the chief factors to be reckoned with : variation as to these factors between the different countries of the world is sufficiently determined to warrant the general statement that a satisfactory transportation practice in one section can be safely adopted by other sections where the same barometric and thermal conditions prevail; therefore, the suggestions presented should be universally useful to carriers of perishable traffic.

Property susceptible to early deterioration and decay is properly subject to the following general classifications :

Products of animals. — Fresh meat, products of packing houses, or abattoirs.

Dairy products. — Butter, cheese, milk, dressed poultry, eggs.

Products of agriculture. — Highly perishable fruits and vegetables, ordinary perishable fruits and vegetables, tropical fruits.

Miscellaneous. — Fresh fish and sea foods, beer in kegs.

This general classification will be employed in the following discussion which will not permit of elaboration of each form of perishable freight.

Because of lack of more detailed information as to foreign practice, your Reporter is forced to discuss methods with respect to each of the classes of perishable freight, from the standpoint of prevailing American practice.

CHAPTER I.

The refrigerator car.

The invention, successful construction and adoption of the refrigerator car, or cold storage house on wheels, marks the first and furthest step toward the accomplishment of the carriers' duty with respect to perishables.

The preservation of food products en route is of greater importance than accelerated transportation, since it is clear the most rapid practicable handling will not, where long distances are to be traversed, prevent the development of deterioration. The multiplication of the ineradicable germs of fermentation and putrefaction is most effectively retarded by temperatures below 50° Fahr. Besides, as these germs develop more rapidly in a moist medium, the science of perfect refrigeration must reckon with the percentage of moisture, or humidity, in the surrounding atmosphere. A normal humidity is shown to be between 70 and 75 per cent saturation, and a safe general formula for efficient refrigeration may be stated thus :

Temperature between 32° and 40° Fahr.
Humidity 70° to 75°.

This formula presumes the application of cleanliness in the preparation of products to secure the maximum external sterility or asepticism.

Mr Bryce in his article, "Preservation of Foods by Cold" (*American Journal of Public Hygiene*, May, 1908), succinctly summarizes these fundamentals of refrigeration :

> The trinity of asepticism, cold, and a proper relative humidity is a sort of *e. pluribus unum*, which must in scientific cold storage be our object of reverence and worship.

The same writer in discussing the availability of cold storage obtained from ice, and from artificial means, asserts the necessity for a constant temperature, attended by a constant percentage of humidity and proves the desirability of mechanical refrigeration for cold storage warehouses. The refrigerator car attains the maximum of efficiency to date in regard to the necessities for cold storage applied in transit; it having so far appeared impracticable to adapt mechanical refrigeration to railway equipment in motion.

The standard American refrigerator car combines with facilities for refrigeration, facilities for movement under ventilation by the forced passage of outside air through the car by opening ice chambers and arranging hatches.

This facility of general use in countries of North America has also been adopted by the English-speaking Managements of Railways in the following countries : England, Australia, the Argentine.

It appears not to have been adopted by the English-speaking Managements of Railways in other countries assigned to your reporter. The following description of the refrigerator car in use on the North Eastern Railway of England, with diagram (fig. 1) is the only detailed data which has been furnished :

A covered wagon of 7 tons capacity fitted with Westinghouse and Vacuum Automatic brake and built to run at fast speeds — Fitted with ice cylinders carried through to the roof so that they can be filled without opening the wagon out — access to the roof by means of fixed step ladder. The wagon is air-tight, india-rubber piping being fitted round the doors for this purpose.

The roof is covered with 7/8 inch boards over-laid with canvas, and there is an interior ceiling of 1/2 inch boards with 2 inches of Silicate Cotton filling the space between. The sides and floor have also an interior and exterior lining of 7/8 inch boards with Silicate Cotton filling the space.

The wagon is zinc-fined, and the lining is easily cleaned by means of water and, where necessary, " Rocklight " cleansing fluid in the proportion of half a pint of fluid to each pail of water.

The wagon has eight cross bars holding 72 hooks inside for slinging beef or mutton carcasses.

No detailed description is furnished by Railway Managements of other countries, except diagram of car in use on Western Australian Government Railways (fig. 2).

A typical refrigerator car in North American service for the transportation of fresh meats is described as follows :

Refrigerator beef car.

General dimensions :

Capacity of car	60,000 lbs.
Length of car over end sills	36 feet.
Width of car over side sills	8 ft. 11 in.
Height of car between sills and plate	7 ft. 1 in.
Length of car between end linings	35 ft. 1 5/8 in.
Length of car between tank aprons	31 feet.
Width of car between linings	8 ft. 5/8 in.
Height of car between floor and ceiling	7 ft. 1 9/16 in.
Loading capacity in cubic feet	1,779.30 cubic feet.
Light weight of car	38,000 lbs.

Floor frame :

Side sills	5 × 9 inches.
Intermediate sills	5 × 9 —
Center sills	5 × 9 —
End sills (oak)	8 × 9 —
Needle beams (oak)	4 1/2 × 8 inches.

Standard double linofelt insulation.

Four ice tanks in each end of car, arranged as shown in diagram (fig. 3).

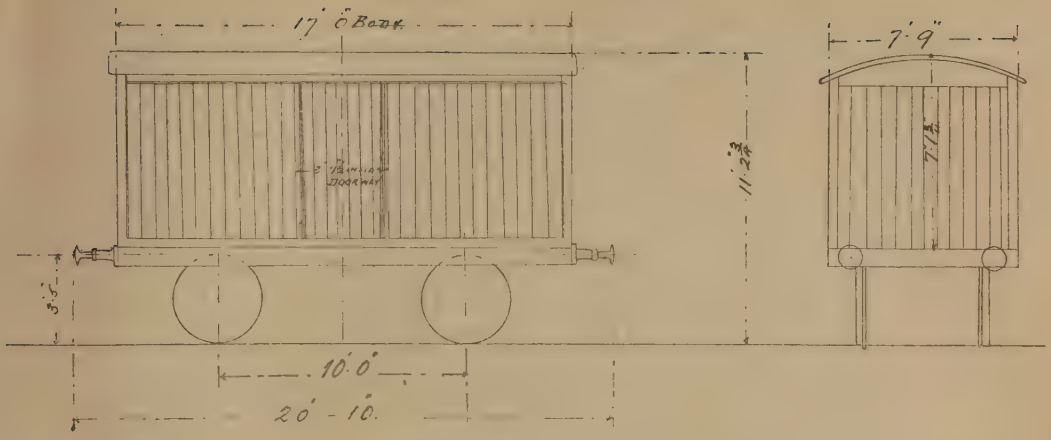

Fig. 1. — North Eastern of England. — Refrigerator van.

To carry 7 tons; tare 9 tons 9 cwt. 0 qrs. — Capacity 648 cubic feet.

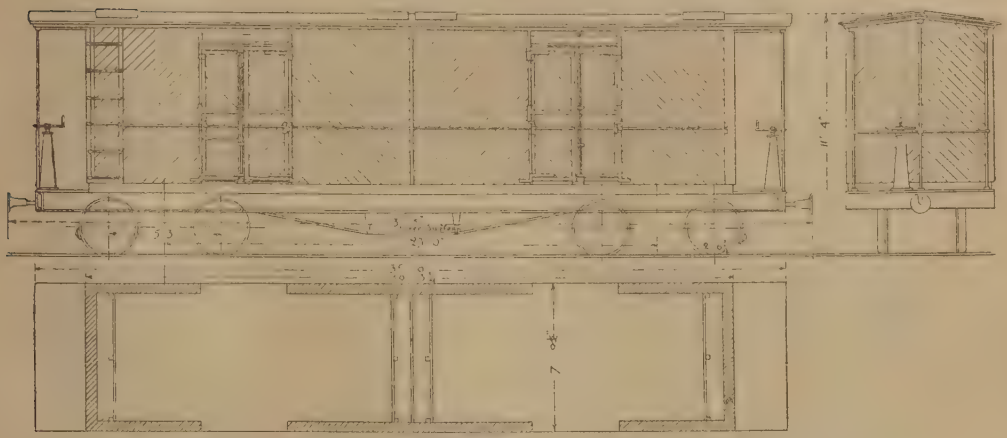

Fig. 2. — Western Australian Government Railways. — Refrigerator van.

TYPE OF UNDER-FRAME.	BRAKE.	BUFFER.	TARE.			MAX. LOAD.			NUMBER IN SERVICE.							
			T.	C.	Q.	T.	C.	Q.	30-6-1900.	30-6-1901.	30-6-1902.	31-6-1903.	30-6-1904.	30-6-1905.	30-6-1906.	30-6-1907.
Compo. .	Hand and train pipe 4	Continuous.	17	5	0	8	0	0	12	12	12	12	12 (*)	10	10	10

(*) Z converted *n*Y.

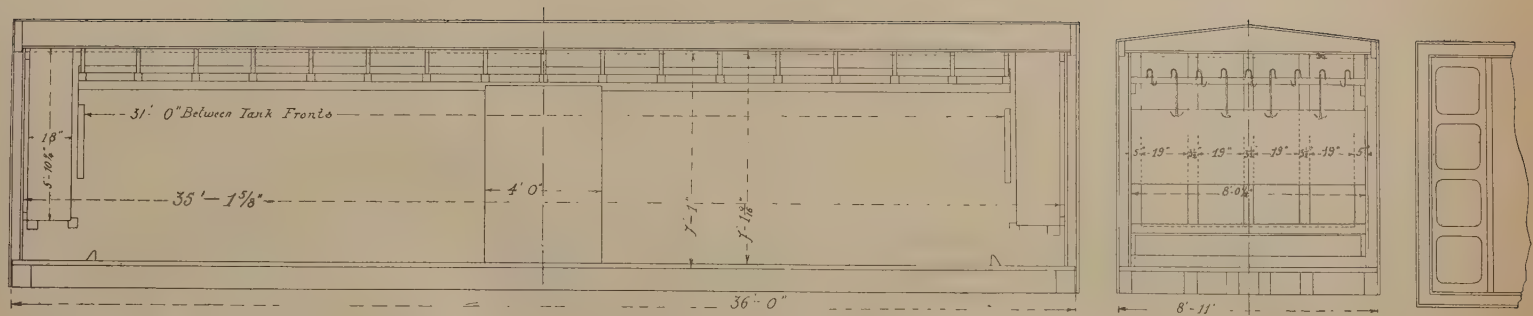

Fig. 3. — Diagram of R. B. 1. beef car showing loading space.

The following describes a type of North American refrigerator car for handling perishables, other than fresh meats :

Refrigerator provision car.

General dimensions :

Capacity of car	60,000 lbs.
Length of car over end sills	38 ft. 8 in.
Width of car over side sills	9 feet.
Height of car between sill and plate	7 ft. 5 in.
Length of car between end linings	37 ft. 11 5/8 in.
Length of car between tank front linings	31 ft. 10 1/2 in.
Width of car between linings	8 ft. 2 5/8 in.
Height of car between floor and ceiling	7 ft. 5 15/16 in.
Loading capacity in cubic feet	1,980 cubic feet.
Light weight of car	38,000 lbs.

Floor frame :

Side sills	5 × 9 inches.
Intermediate sills	4 × 9 —
Center sills	4 1/2 × 9 inches.
End sills (oak)	6 × 9 inches.
Needle beams (oak)	4 × 8 —

Standard double linofelt insulation.

One ice box at each end of car, arranged as shown in diagram (fig. 4).

It should be borne in mind that while refrigerator cars, partially worn or not of the highest type, may be suitable for the preservation of certain types of perishables, they may not be suitable for other types of perishables. To illustrate : fruits and vegetables, permitting a somewhat wider range of temperatures inside the car during transit, may be successfully handled in refrigerator cars, which may have lost some of their original value in the beef trade. On the other hand, the refrigerator beef car is equipped with ceiling racks and hooks, and cannot, be economically employed in the fruit and vegetable trade.

The following table exhibits the carrying capacity of these three types, and displays a preponderance of dead weight in connection with the Western Australian and the American cars. This is accounted for, as to the American car, mainly by necessity for heavier construction, particularly in the underframe, to stand movement over long distances and widely varying surfaces, and consequent severe usage :

	Weight of car.	Capacity.	Total weight under load.	Percentage of dead weight.
North Eastern Railway of England	18,900 lbs.	14,000 lbs.	32,900 lbs.	59
Western Australian Railways	34,500 lbs.	16,000 lbs.	50,500 lbs.	68.31
Standard North American car	38,000 lbs.	60,000 lbs.	98,000 lbs.	63.33

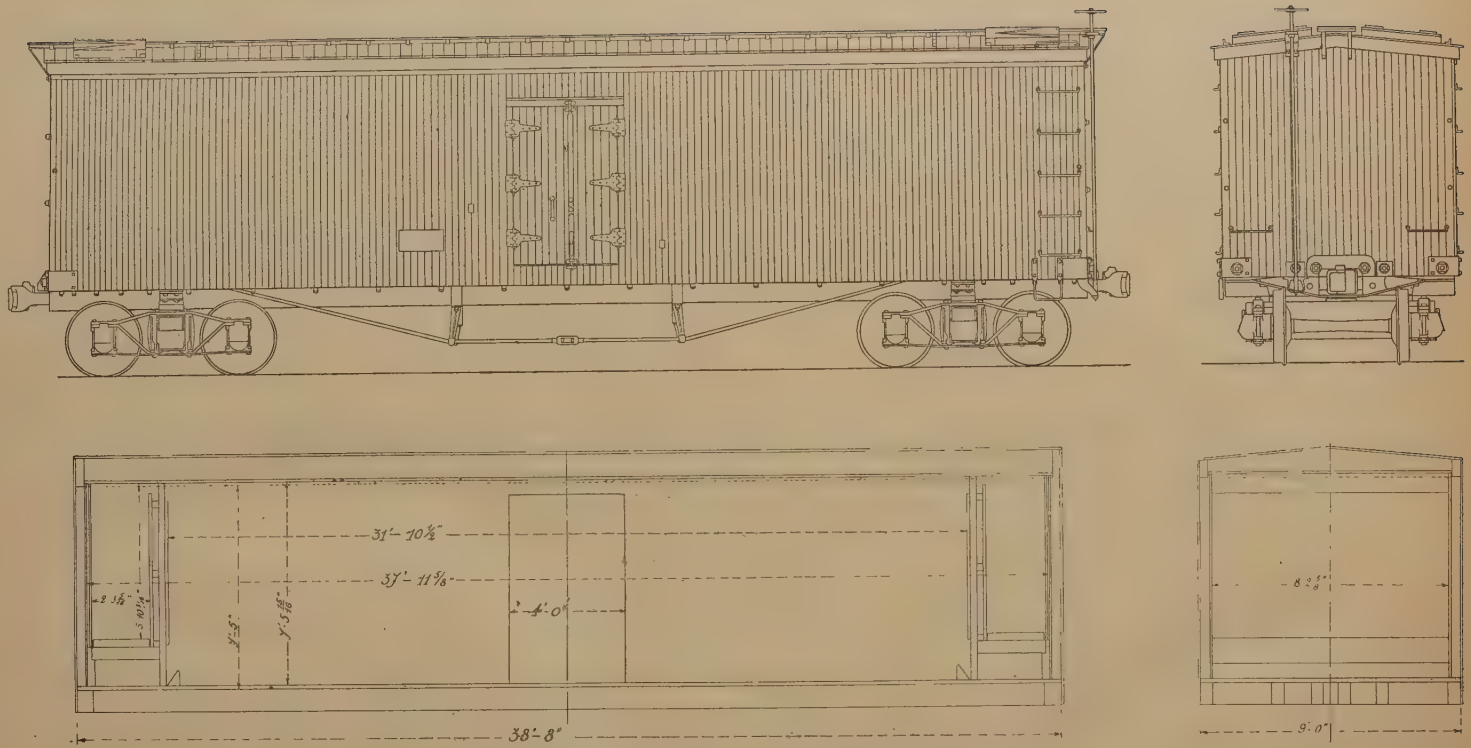

Fig. 4. — Diagram of R. F. 1. fruit car showing loading space.

It cannot be successfully contended that the American car sacrifices carrying capacity to improve refrigeration; experience has proved its adequacy and success in both respects.

The present American types of cars have been evolved from experiments beginning, according to the best authority, with the refrigerator car patented by William Davis, of Detroit, Mich., in 1868, although experiments had been, previous to that time, conducted by W. W. Chandler, an official of the Pennsylvania Railroad, in connection with box cars with double sides, roof, and floor, insulated with sawdust, and iced by the insertion of a box of ice in the door of the car, after it had received its loading. Both of these experiments were directed to successful transportation of dairy products and fresh meats.

The Davis Car is described by D. W. Davis, the son of the inventor, as follows:

The shed of the car is constructed with a dead air space entirely around the top, bottom, sides and ends of the car. On the interior are placed layers of hair felt, two inches in thickness, and this is again lined with an interior wooden shell. This construction makes a non radiating and non-conducting wall of great power to resist the action of external heat and renders the expenditure of ice quite small to maintain the required depression of temperature after the interior of the car and its contents have been cooled down to the proper point, say from 54° to 58° Fahr. Along the sides of the car are placed galvanized iron tanks, which extend from within one inch of the top of the car to within three inches of the floor. These tanks are 4 1/2 inches wide at the top, and taper (wedge shape) to 2 inches wide at the bottom. The tanks communicate at the top with funnel or hopper-shaped openings fitted with tight plugs, and at the bottom through drip pipes, with proper traps which carry away the drippings. The funnel shaped openings on top are used for putting in the refrigerating mixture, consisting of broken ice and salt. The tanks, or ice receptacles, are so placed in the car as to allow free circulation except on the ends, which are closed up.

In operation, the ice receptacles are charged with ice and salt — about ten pounds of salt to one hundred pounds of ice — which reduces the temperature of the surface of the iron below the freezing point; the narrow space between the ice receptacle and the wall being much cooler than the chamber of the car, the cold air drops down of its own gravity, passing out underneath the receptacles into the body of the car. By this circulation of the air, all the warm air and all vapors from the meats, fruits and vegetables are automatically drawn over the top, and, coming in contact with the iron that is below freezing point, the moisture of the air is deposited on the walls of the receptacles in the shape of hoar frost, thereby purifying the air as it descends, and, as it passes into the chamber, it is ready to take on another load of moisture.

A refrigerator built on this plan can be regulated to any degree required, either above or below the freezing point, by the quantity of salt that is used on the ice; the current of cold dry air is maintained without the introduction of external air. The air is perfectly dry, as all moisture is frozen out.

This car was built primarily for the transportation of fish, in which the firm of Davis & Company was largely interested, and its adaptation to the dressed beef business was undertaken by Mr. Geo. H. Hammond, of the firm of Hammond-Stan-

dish & Co., of Detroit, Mich.; the first shipment of beef in these cars being made and accompanied by Mr. Hammond sometime during the year 1869.

There have been numerous patents for improvements on the general theory underlying the Davis Car; notably the Wickes and Tiffany patents, which are described by *Ice and Refrigeration* (Chicago and New York, November, 1901, vol. 21, No. 5, p. 207) as follows :

In 1877 two patents were issued for the construction of refrigerator cars, which afterward became the basis of what were designated systems. Patent No. 189,001 was issued to James H. Wickes on March 27th of that year; his plan was to place the ice tank at one end of the car adjoining the provision chamber, and at the other end was an air chamber, which connected under the ceiling with the provision room. This air chamber extended across the full width of the car, down the end and under the floor to a fan blower in the center. The fan (which was operated by a power attachment from the axle of the car when the latter was in motion, or by hand when it is at rest) drew the air from the provision chamber through the air space and ice tank, whence it escaped at the bottom, and was distributed across the width of the car into the provision chamber. As the water accumulated from the meltage of the ice it raised an automatic float valve, and the surplus water escaped without admitting the outside air.

On 24 July, 1877, patent No. 195,557 was issued to Joel Tiffany, of Chicago, the ice in his car being located in a tank placed above the roof in a separate compartment. The under side of the galvanized iron tank formed the roof of the provision chamber. Outside air is admitted through horizontal air passages, which have openings at the corners of the car. In cold weather these openings were to be closed with stoppers. Tubes connected the provision chamber with the air space, permitting the escape of foul air. At each end of the compartment, or story, containing the ice tank was an opening for the outer air to enter, provided with a regulating valve and shutter. The air passed down into car through pipes to the water tank containing the melted ice. A wire screen kept out the cinders, while the water over which the air was drawn absorbed the dust, The air was then carried by pipes to the ice tank, the ice resting directly on the pipes, and distributed when cooled by smaller pipes, running lengthwise of the car. Refrigeration and circulation were thus accomplished entirely by automatic methods. Such devices as the fan blower being rejected.

The Davis theory was adopted by Armour & Company on account of its simplicity, and its evolution has produced the Hamilton Car, in which the insulation is obtained by construction combining wood, air space and hair felt; the roof, walls and bottom of the car being 7 inches in thickness, with the dead air space, and three 1 inch layers of hair felt. The joints of the doors are padded to make them air-tight when closed. The ice receptacles are simply strong galvanized iron cans, four of which will fill each end of the car. These extend from the roof to within six or eight inches ot the floor, and under them is a pan to catch the drip, the over-flow escaping through an air-tight trap.

The ice is loaded through the roof, being crushed into small pieces and mixed with fine rock salt. The cans are then filled (each car holding about 6,500 pounds

of ice) and the covers are put on and closed. No air enters the car and there is no provision for mechanical circulation of air within the cooling chamber.

After the cans are thus filled with crushed ice and salt the car is allowed to stand for some twenty-hours, the temperature within being reduced to about 33° Fahr. The car is then re-iced about 1,000 pounds being usually required for this purpose), and is then run into the cooling room of the packing house to receive its load of meat. The temperature of the car and cooling room is practically the same.

No improvement effected by carriers — not excluding quicker schedules — has produced such economic results as the refrigerator car. The present fresh meat, fruit and vegetable industries represented in America by millions of dollars investment, and affecting thousands of square miles of territory, are almost entirely the product of this device. It is quite conceivable that if cars containing perishables moving over long distances could be kept constantly in motion and not be stopped, even for a short time, at terminal points of the intermediate roads making up a through route, ventilated cars might in many cases be substituted for refrigerator cars; but the inevitable stops en route at intermediate terminal points make such substitution unsafe. As the production and distribution of fresh meats have evolved the past thirty years from strictly local distribution, or the less economical transportation of live-stock over long distances, into a national wealth reaching into the millions : so the traffic from fruit and vegetable growing districts — in many cases previously undeveloped in this character of traffic — has brought wealth to wide areas, and thousands of individuals. The following tables and statistical data show results to producers, and give evidence of growth in volume of carriers' business :

Slaughtering of Cattle and Hogs.

Report of United States Commissioner of Corporations, on the beef industry, 3 March, 1905.

1880	8,305,894 carcasses.
1890	15,070,809 —
1900	24,084,265 —

Statistics showing actual movement of fresh meat and packing house products under refrigeration have not been obtainable in carloads. However, the above table indicating the total slaughterings at principal slaughtering points, taken in connection with the statement of a competent authority that all shipments of cattle and hogs are made in refrigerator cars, quite clearly indicates the growth of the industry, and the traffic created thereby, a result founded upon the use of the refrigerator car.

The following table shows the movement of fruit in years when there was no failure of crop, total or partial, commencing with the earliest year for which a record was kept.

This development is made possible by the use of the refrigerator car, and reflects growth of an industry from, primarily, one County to a large portion of the State,

bringing hundreds of thousands of dollars added revenue to the producer and carrier.

Movement of citrus fruits from California.

(California Fruit Grower, 22 December 1906).

Date.	Carloads.	Percentage under refrigeration.	Date.	Carloads.	Percentage under refrigeration.
1894-95.	5,575	...	1900-01.	24,900	47 per cent.
1895-96.	6,915	...	1901-02.	19,180	33 —
1896-97.	7,350	...	1902-03.	23,871	48 —
1897-98.	15,400	22 per cent.	1903-04.	29,299	40 —
1898-99.	10,875	17 —	1904-05.	31,422	51 —
1899-00.	18,400	28 —	1905-06.	27,610	...

Deciduous fruit shipments from California.

Date.	Carloads.	Date.	Carloads.
1895.	4,568	1905.	8,224
1901.	7,136	1907.	7,750

Movement of peaches from State of Georgia.

Date.	Carloads.	Date.	Carloads.
1889	150	1898	2,500
1893	250	1904	4,800
1895	743	1908	5,000 (approximate).

Movement of Strawberries.

The strawberry, owing to its extremely perishable nature, cannot be transported in carload lots over long distances, except under refrigeration, and the following figures furnished by a carrier in the South-Eastern section of the United States, whose territory is adapted to strawberry culture, show how quickly and effectively the culture af the strawberry has responded to the use of refrigeration methods by the carrier in question : the diminution in the movement during the years 1907 and 1908 is due entirely to partial or total failure of crop :

Date.	Carloads.	Date.	Carloads.
1897.	425	1903.	1,975
1898.	675	1904.	2,109
1899.	950	1905.	2,022
1900.	1,100	1906.	2,613
1901.	1,150	1907.	907
1902.	1,220	1908.	1,095

Early Vegetables.

The traffic in vegetables has been so diversified as to preclude an exhibit for each type. It has not been confined to refrigerator cars, but as to certain varieties of vegetables, ventilated cars have been largely employed. Furthermore, it has been found difficult and burdensome for carriers to compile aggregate tonnage for a period of years. However, there has been a development of this traffic in the tide water districts of Virginia, the Carolinas and Georgia, the entire State of Florida, and the States of Alabama, Mississippi, Louisiana, Texas, Arkansas, Tennessee and Southern Illinois, the volume and importance of which is illustrated by the following figures for the years 1906, 1907 and 1908, furnished by one of the largest and most successful carriers of vegetables operating from a section of this territory of average productiveness :

Freight Receipts.	Tonnage.	Revenue.
1906	332,248 tons	$ 1,019,662·04
1907	467,179 —	$ 1,327,280·93
1908	365,583 —	$ 976,223·94

Cantaloupes.

On this important branch of perishable traffic, Mr. L. D. H. Weld, Garth Fellow in Political Economy, Columbia University, New York City, in his treatise, *Private Freight Cars and American railways*, says :

The Rockyford cantaloupe was first grown for markets at Rockyford, in the south eastern part of Colorado in 1885... In 1894 the growers co-operated and shipped for the first time in carload lots. Transportation facilities were not adequate for the handling of the crop, and the adjacent markets were flooded with melons with consequent loss to the farmers. It was not until 1897 that shipments were made as far East as New York by means of the refrigerator car... In 1897, there were one hundred and twenty-one cars shipped from the Rockyford District, in 1904, the number had increased to one thousand, one hundred and eighty-two... Prior to 1897, the high prices and limited supply made the cantaloupe a great luxury... New York had been supplied for years with an inferior melon... when the superior qualities of the Rockyford became known, other districts all over the country began to raise it — principally Carolinas, Florida, Georgia, Texas and California... The cantaloupe is a highly perishable commodity, and requires careful handling and supervision in transportation. It thus furnished, perhaps, one ot the most striking examples of the change that has been wrought by the refrigerator car on our agricultural development. In 1897 the amount consumed in the United States was not over 400 carloads : this amount gradually increased, until during the year 1905, 6,920 carloads were used throughout the country, and the season for cantaloupes has changed from a period of less than two months to six months of carload business.

An obvious effect of extended production, supplemented by cold storage and refrigeration-in-transit, is stability of supply, and increasing efficiency of organiza-

tion for marketing has brought about a scale of prices for products, at once profitable to producer, and attractive to consumer. It must be apparent that the credit for this result is largely due to refrigeration-in-transit, to the benefit of the carriers who have installed this refrigeration service.

CHAPTER II.

Practice of English-speaking Managements other than North America.

Responses to inquiries transmitted through the General Secretary of the Congress have been received from the English-speaking managements of railways in the following countries : The Argentine, England, India, South Africa, Australia, Mexico.

A brief description of the practice in handling perishable freight in the respective countries as indicated in these replies, follows :

THE ARGENTINE.

The outside temperatures are characteristic of the Temperate Zone, without excessive heat or cold, except that excessive heat is experienced in the Northern Provinces. It is not found necessary to adopt facilities to modify the natural temperature, with the exception of milk, butter and fish. Milk and butter are transported in cars or wagons, different from ordinary goods wagons only in the fact that they are lined inside with wood and provided with amianthe or other uninflammable stuff in the intervening space between the inside and outside walls. The only refrigeration used is ice which is placed in the wagons or around the tin packages. Fish is transported in boxes packed with ice, either ordinary cars or the above described equipment being used. All equipment is owned outright by the railways, and cold storage, pre-cooling, or other facilities supplied entirely by and at the expense of the shipper. Movement takes place over short distances, and existing equipment is felt to be adequate : no information furnished as to measure of refrigeration charges, method of stowage, or rules for general conduct of perishable business.

ENGLAND.

Temperatures ranging between 20° and 88° Fahr., with relatively short distance movement and high speed trains have greatly modified the necessity for specializing the handling of perishable freight. Although each of the respondent managements reports that perishables originate to some extent on their lines, the need for special

facilities appears mainly in connection with imports. But a relatively small part of the perishable list requires refrigeration-in-transit-which in accomplished by the type of refrigerator car described herein (fig. 1). Other wagons for handling perishable freight are designated as :

Insulated.

A covered wagon of 7 tons carrying capacity built on the same lines as the refrigerator, but without ice cylinders.

Hooded Perishable.

A covered wagon of 5 tons carrying capacity, fitted with Westinghouse and Vacuum Automatic brake and built to run at fast speed. The roof is covered with a single course of 1 ¼ inch boards over-laid with canvas. The sides and ends are doubled cased with air space between, and the floor is of heavy planking in a single thickness.

This wagon is provided with 8 cross bars holding 72 hooks and is ventilated by means of louvres there being six louvres at each side (two at top and one at bottom of wagon at each side of doors) and two at each end (one each at top and bottom). The top end ventilators are fitted outside with a projecting wooden hood which to some extent prevents the entrance of dust, etc., and the bottom end ventilators are fitted, *inside* the wagon, with a drop door which can be let down when less ventilation is required.

Whilst admitting air, these ventilators are also liable to admit grit and soot, and, to prevent this as far as possible, the wagon has two sheets of perforated zinc inside each louvre (one fine and one coarse mesh) and in addition to this some of the wagons have a layer of very fine copper gauze between the two zincs.

Even this was not found to be sufficient protection from soot and grit in the case of fresh mutton carcasses loaded direct from the slaughterhouse, often whilst hot, and always without wrappers, and the wagon is now fitted with screw studs round each louvre to enable it to take a "Blind Protector". This appliance was suggested and designed as the result of continued claims for dirty mutton and after full consideration of various methods of preventing the entrance of soot and grit, and, at the same time, admitting sufficient air. The "blind" is made of a sort of horse cloth American leather, the rough surface being next to the louvre where it catches and holds the flying dirt, whilst the leather surface, which is easily washed, faces the interior of the wagon. The rough surface is brushed at the receiving end before the blinds are returned to sending station for further use.

Since the use of this blind, there has been no complaint of dirty meat where the blinds have been used.

Perishable.

Same as the hooded perishable but not provided with the hood and drop door in connection with the end ventilators, and the studs for the blind protectors. When wagons are required for mutton carcasses, the hooded type are supplied.

Meat.

A covered wagon of 8 tons carrying capacity, built to run at fast speeds; fitted with the Westinghouse and Vacuum through pipe.

Has six louvre ventilators; four at sides (one at bottom of wagon each side of doors) and two at ends (bottom).

Fish (covered).

A covered wagon of 10 tons carrying capacity, built to run at fast speeds, and fitted with Vacuum Automatic brake and Westinghouse through pipe.

The wagon is ventilated by means of four louvres at the top of the wagon sides (two at each side), placed at either side of the wagon door, which doors slide instead of opening outward or dropping.

The wagon is lead lined for three feet up the side and is fitted with shelves at each end for the conveyance of *dry* fish.

Some of this type have the floor boards covered wit " Adamant and Asphalt " paving, whilst the sides are lined with sheet zinc giving a sanitary and easily cleansed interior.

The major portion of the *wet* fish in carried in kits, but for dealing with bulk fish, doors, which can be slotted to make the wagons more or less of a tank, are provided.

Fish (open).

An open wagon of five tons carrying capacity built to run at fast speeds and fitted with Westinghouse and Vacuum Automatic brake.

The wagon has latticed sides and sliding doors. 50 of this type are lead lined.

Strawberries and Gooseberries are transported in wagons fitted with shelves sloping to sides and ends, which wagons when not employed in horticultural traffic are used for import cheese.

Milk is transported by passenger trains in specially designed wagons or vans, characteristic type of which is 32 feet long with eight tons carrying capacity, the essential feature of which is ventilated sides, lined with zinc from the floor up to a distance of three feet (fig. 5).

All equipment is owned directly by individual carriers, and refrigeration charges are usually included in the conveyance rates.

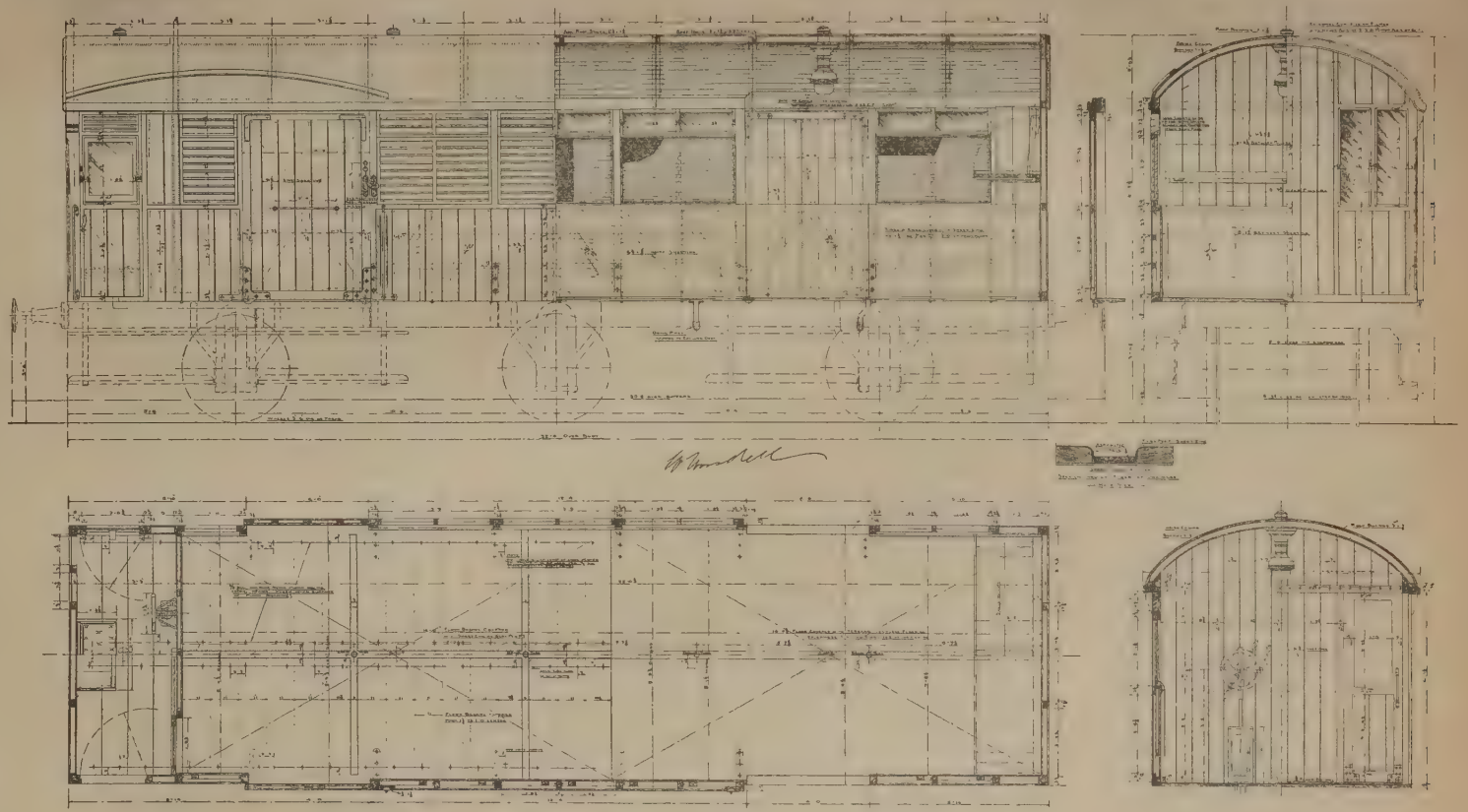

Fig. 5. — North Eastern Railway of England. — Body for 32 ft. 0 in. milk vans.

Tare 14 t. 2 c 0 q. — To carry 8 tons.

All cold storage or pre-cooling facilities are owned and operated by shippers. The present facilities appear to be adequate for all existing requirements.

No suggestions are offered by respondents looking to improvements for the increase of traffic.

As English Railway Managements apparently rely mainly on rapid transit for the successful handling of perishable traffic, the following regulations of the North Eastern Railway for the consist of " Braked Freight Trains " are pertinent :

Braked freight trains.

1° These regulations refer to trains which are signalled by " Is line clear? " signal; 5 consecutively, and also to fish and meat trains from Scotland, which are signalled 4 consecutively.

2° For the purpose of calculating the number of braked vehicles of which the train is to be composed the following table must be observed :

Engine counts as	3	vehicles.
Tender counts as	2	—
Tank engine counts as	3	—
— or six wheeled vehicle	1	—
8 wheeled bogie	2	—

3° These equivalents differ from those given above which are for passenger trains only;

4° Braked freight trains are divided into the four following classes :

Freight trains booked at over 45 miles per hour average (class 1).

This train must be composed of vehicles built on coaching stock lines, tight coupled and piped throughout. If the van is piped but unbraked, the next vehicle within it must be braked.

Freight trains booked up to 45 miles per hour average (class 2).

These trains must be tight coupled. The whole of the vehicles need not be braked, or piped, but in other respects they must comply with coaching stock requirements. Unpiped vehicles in all cases to be in the rear next within the van.

Freight trains booked up to 40 miles per hour average (class 3).

These trains must be tight coupled, and have long buffers, oil boxes and 8 ft. 6 in. minimum wheel base. The springs must be secured to hangers or be bolted. (This includes springs bolted to axle-box or to the shoes.)

Freight trains booked up to 35 miles per hour average (class 4).

The trains must be composed of tight coupled wagons with their springs secured to hangers or bolted, except that not more than two slack coupled wagons may be placed in the rear within the van, provided their gross weight does not exceed 30 tons. (This includes springs bolted to axle-box or to the shoes.)

INDIA.

From replies received, perishable traffic is restricted to fruits, vegetables, dairy products and fish. All perishables are now handled in vans only, and without refrigeration, except in the case of fish, which are packed in ice by shipper. The following quotation from the Secretary of the Indian Peninsula Railway to the Acting Director of Agriculture at Poona, dated Bombay, 16 November, 1907, seems to present the attitude of the Indian Railways toward the adoption of special cold storage wagons :

" As regards the provision of cold storage vans, this Company has not so far constructed any such vans, as there have been no demands for them, and I think it would be accepted that it would not be sound policy to construct such vans unless there is a reasonable chance of their being regularly used. Cold storage is not a cheap means of transit, and it is doubtful whether, if constructed, there would be a demand for the vehicle. However, if the Chamber of Commerce will enter into more details and show where such vans could be used with financial success, this administration will be prepared to consider the matter further. "

It should be stated, the above quotation is a reply to an opinion expressed by the Chamber of Commerce, Bombay, that the development of vegetable and garden produce traffic might be obtained if steps were taken in the direction of :

1° Organizing more rapid system of transit;
2° Construction of cold storage wagons.

The Managements of Indian Railways unquestionably feel that with the present demands their traffic in perishables does not require the use of other than ventilated vans or wagons handled in passenger train schedules : a conclusion which your Reporter must assume to be sound, although it is proper for him to call attention to the results which have been attained under American practice from the quick and satisfactory delivery of reasonably fresh fruits and vegetables in large consuming centers. In India, the principal centers of distribution for perishable products appear to be the ports where there is to be served not only a large non-producing local population but an export trade which might be promoted to adjacent foreign countries, China, Australia, etc., not possessing, in all probability, the same variety of fruit and vegetable production as may be found in the Indian Peninsula.

From demonstrated results in other sections of the civilized world, it may be found by the Managements of Indian Railways in the fruit and vegetable traffic a fertile opportunity, not only for increasing their own revenues, but for stimulating the production of a variety of food products lessening the disastrous effects upon the people, resulting from the occasional failure of any one of the crops now grown. In the absence of comparative statistics, your Reporter is unable to form an opinion of the progressive development by the Indian Railways, but the present existence of traffic in both directions argues that the subject has already received practical and effective consideration.

SOUTH AFRICA.

The perishable traffic of South Africa does not differ substantially from the list given at the outset. Refrigerator or brine-cooled trucks are employed for the transportation of fresh meats and dairy products, ventilated equipment for the transportation of other perishables for distances up to one thousand miles; diagrams and detailed descriptions of these two classes of equipment have not been furnished. The existence of cold storage facilities under the ownership and control of shippers indicates the permanent establishment of the traffic in perishables, and that carriers are addressing themselves to its successful transportation.

The climatic conditions vary from sub-tropical to temperate in movement from tide water to considerable altitudes. Temperatures for the month of February, 1908, taken in brine-cooled trucks working between Mooi River (altitude, 4,556 feet) and Johannesburg (altitude, 5,735 feet) a distance of 357 miles, show fluctuation between starting point and destination, varying from a fall of 4° to a rise of 15° Fahr. The variation takes place between points whose outside maximum mean temperature varied by 10.4°, while the minimum mean temperature varied only 2.8°.

In other words, there was a tendency of the temperature inside the trucks to rise, while the tendency of the mean outside temperature was to fall. The nature of the load is not given and no opinion can be formed of the cause for this apparent discrepancy in variation between outside and inside temperatures. However, from the inside readings taken at an intermediate point which evidenced a tendency to depression in the inside temperature, the inference may be drawn that sufficient refrigeration was not supplied for the distance to be traversed and that refrigeration was not supplied at intermediate points. Replies indicate satisfaction on the part of the shipping agents, traders and receiving public, justifying conclusion that the subject is receiving attention at the hands of the Railway Managements to the end of fully developing the traffic.

AUSTRALIA.

Two respondents, The Western Australian Government Railway and New South Wales Government Railways, report the existence of a perishable traffic as described

at the outset, except eggs, butter and cheese, making the further statement that agricultural, and dairy farming are practically in their infancy. They further report a variation from 40° to 115° shaded temperature during the year, through the districts traversed, for the equalization of which refrigerated louvred vans are provided. A diagram of the refrigerator vans is furnished (see fig. 2). The louvred vans, the type of which is shown by diagram (fig. 6) is a metal construction and has a dead weight of 12,800 pounds, with a loading capacity of 15,000 pounds, with still another type also shown, of wood and metal construction (fig. 7), with a dead weight of 9,400 pounds, and with a carrying capacity of 12,000 pounds.

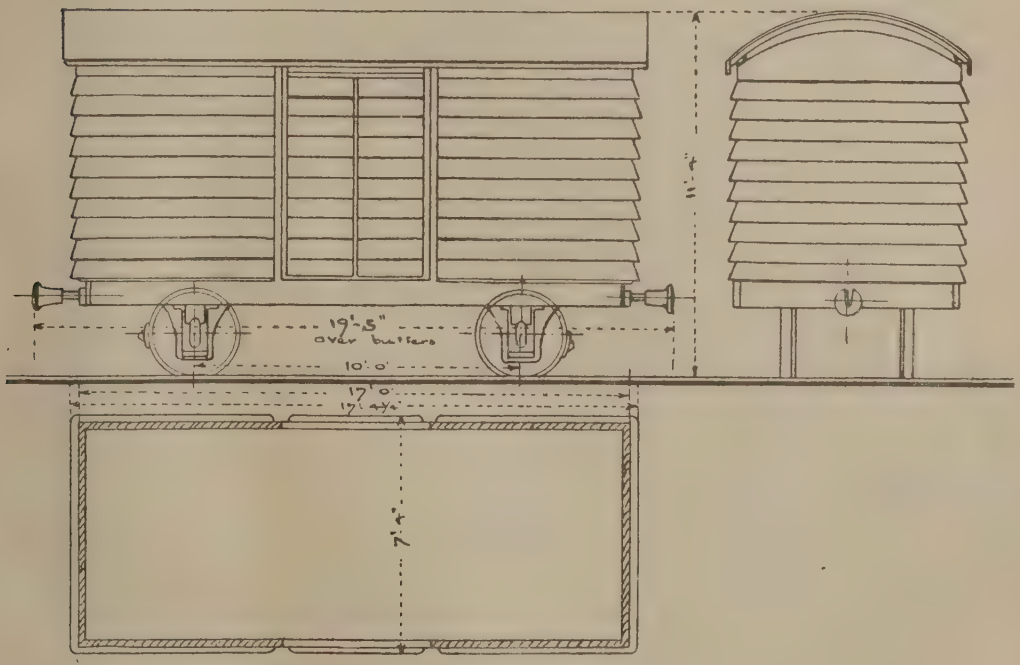

Fig. 6. — Louvre meat van.

CLASS OF VEHICLE.	TARE.			LOAD.			If sides and ends are let down throughout.	Area of floor space.	Nature of brake.	Quantity available. 1906	30 June 1907.
	T.	C.	Q.	T.	C.	Q.					
Fa.	6	8	0	7	10	0	Covered vehicle.	106 square feet.	Vacuum and hand.	52	52
Fa.	6	7	0	7	10	0	Id. id.	91½ id.	Id. id.	5	6

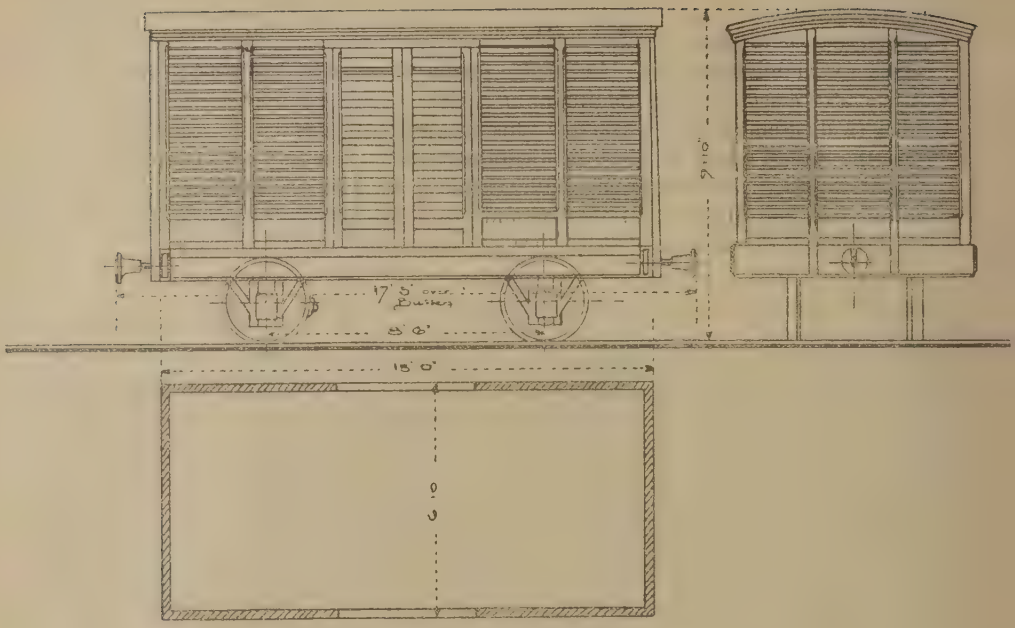

Fig. 7. — Louvre meat van.

CLASS OF VEHICLE.	TARE. T.	C.	Q.	Load.	If sides and ends are let down throughout.	Area of floor space.	Nature of brake.	Quantity available. 1906.	30 June. 1907.
F.	4	14	0	6 tons.	Covered vehicle.	91 3/4 square feet.	Hand and train pipe.	12	12
F.	4	15	2	5 tons.	Id. id.	99 1/2 id. id.	Id. id.	2	2
F.	4	14	0	5 tons.	Id. id.	94 1/2 id. id.	Id. id.	6	5

The Australian situation is unique, by reason of the encouragement being given by the Government through the provision of cold storage depots, which together with the provisions already made by the carrier presages a large growth of traffic in that territory. From the information furnished, it is observable furthermore that carriers, by concession in rates on fertilizer and manure, are stimulating production.

Private cold storage arrangements at point of shipment and destination, constitute an additional factor in the upbuilding of the business.

In the absence of more detailed information as to distance to be traversed, and

variations of temperature to be overcome, useful suggestions for improvements on the present practice applicable only to the Australian situation cannot be made.

MEXICO.

An interesting feature in perishable traffic in Mexico is the handling of pulque, a native vegetable liquor, which although subjected before shipment to a process of fermentation, is highly perishable. This traffic is transported in barrels in cars similar in construction to ordinary stock cars, and handled by special daily train service. The length of the haul on this product is not stated, nor any information given as to the schedules required to be maintained.

The practice and equipment for the handling of perishable freight in Mexico does not differ from that in the United States of America, although it is noticeable that the carriers only operate their own refrigerator equipment, and furnish icing at actual cost. It is stated that no free weight allowance is made for the ice, and under Mexican practice the shipper pays for the full load. Although the variation in temperature is from that of the Southern North temperate to that of the Northern torrid zone, the rise in the temperature over the distance traversed is not uniformly gradual, but is irregular, owing to the varying altitudes at intermediate localities. The chief protecting measure employed is prompt transportation, equipment in refrigerator cars being limited and generally used for the transportation of beer and ice. There would seem to be opportunities for increasing the production and carriage of perishable freight from Mexico, particularly for export, under the system successfully used in other territories.

CHAPTER III.

Fresh meats and products of packing houses.

In addition to fresh meat, the most important output of packing houses for domestic consumption are dried salted, and cured meats, and lard. The by-products, tinned and cannet meats, including sausage, butterine and beef extract, while demanding great care and attention to details of handling and shipping, are not so exacting as is traffic in bulk articles.

Fresh meats for distribution and consumption in North America require primarily a chilling process. Meats are not frozen, except in some cases for export movement over long distances, and also, where it is desired to preserve a supply of special goods for special consumers. The usual widely adopted process of chilling fresh beef is found to be satisfactory for shipping and holding for periods as long as sixty

days; the meat improving in quality during the first two weeks, remaining in most desirable condition for the next two weeks, when slow deterioration is likely to begin and continue for a period, varying with original quality, original refrigeration and conditions of refrigerators in which kept, up to probably six weeks from slaughtering. It is the aim of the packer, co-operating with the transportation line, to effect delivery under regular schedule and in regular quantities during the first four weeks after slaughter, which is done by maintaining temperatures in storage houses and in cars, according to the following table taken from *Compend of Mechanical Refrigeration and Engineering.*

(Seibel) :

Beef, fresh	37 to 39° Fahr.
Hogs	30 to 33° —
Livers	30° —
Mutton	32 to 36° —
Tenderloins, butts, ribs	30 to 35° —
Veal	32 to 36° —

Experts differ with the above author, prescribing temperature of 32 to 34° for beef.

Preservation by refrigeration of the different parts of the hog has received special study, resulting in the utilization of practically the entire animal. The prime factor is prompt refrigeration, and the maintenance of a standard circulation of dry cold air. The ribs, more fully described as the large cut which comes out of the back, containing the back-bone and about 2 $^1/_2$ inches of ribs, being the part from which pork-chops are taken, is the part of the animal demanding first and best attention. These ribs are boxed and covered with clear paraffin paper, and call for a temperature of 26 to 28° under conditions protecting against dampness or dripping on the boxes or the product.

The prevailing type of meat car is cooled by ice bunkers at each end of the car, which removes much of the danger of moisture precipitation on the ceiling and walls, but methods might be studied with profit, looking to the still further reduction of moisture percentage in the atmosphere of these cars, to effect satisfactory delivery of hog products, particularly the rib cut described above. Other highly perishable products of hogs, such as sausage and sweet pickled meats, are now handled in a manner procuring satisfactory results.

Modern practice prescribes as the primary requirement for satisfactory preservation, the complete expulsion of animal heat, to be accomplished as speedily as possible, after removal of the skin and evisceration and cleansing, but observing great care not to produce freezing of the outer tissues which results in the generation of internal decay, or " bone-stink ". The steady application of a temperature not below 30° and not exceeding 32° has been found to accomplish the best results.

Pre-cooling thus seems to be an absolute essential in the transportation of this product, and is furnished in every case by the producer or shipper. The duty then

remains to the transportation interests to assist in the maintenance of the desired temperature during the period of transportation. Except where re-icing is done en route, under the direct supervision of the shipper, the transportation line is required to provide facilities for re-icing, including not only ample supply of ice, but skilled attendance.

Figure 3, showing a typical refrigerator car for the transportation of beef, contains refrigerator tanks, four in number, circular in form, about 15 inches in diameter, at each end of the car, which are to be charged with a mixture of ice and salt : the ice crushed into pieces ranging from the size of a cocoa-nut to the size of a walnut, to permit close packing : the salt consisting of crushed rock salt, known to the trade as No. 3, with crystals the size of a hazel-nut, and smaller. The proper proportions of salt and ice necessarily form a very important part of the training of attendants : a successful formula being 90 per cent ice and 10 per cent salt. The resulting brine has a temperature often times under zero Fahrenheit, which shows some loss of refrigerating energy, but so far no means have been discovered to prevent this loss. It has been conclusively shown that the absolute requirement of a temperature in the handling of fresh meats of different kinds ranging from 28 to 34°, cannot be obtained without the use of salt. A fruitful field for investigation is open to transportation lines at this point, seeking to discover greater economy in the use of both ice and salt, without the loss of refrigerating energy referred to.

Experience so far, proves that varying the proportions of ice and salt will not accomplish the economy desired, because a much lower temperature is necessary in the contents of the tanks than is to be found in the body of the car. In order to preserve the low temperature necessary in the body of the car, the only variation in the mixture of ice and salt is determined by outside thermal conditions. The problem of utilizing the refrigerating energy wasted in the overflow brine, must find its solution in appliance for catching and holding this brine so distributed around the body of the car as to continue the action of refrigeration. Attempts have been made to accomplish this by utilizing a series of pipes, but in practice this method has been proven unsatisfactory because ice always contains more or less extraneous substances which clog the pipe. Experiments are being constantly made by experts in packing houses in this direction.

Provisions, that is, salted meats shipped in boxes or casks, as well as dry salted meats, require refrigeration in transit.

Siebel's figures being as follows :

Brined meats	35 to 40° Fahr.
Hams, ribs, shoulders (not brined)	30 to 35° —

Other authorities make these figures :

Brined meats (provisions as described above)	36 to 38° —
Dried salted meats (not brined)	38 to 40°

Carcasses prepared for shipment are cut in two quarters : each quarter suspended from a hook secured to a rack, fastened to the ceiling of the car. Small animals are likewise suspended. Under American practice each piece is covered with thin loosely woven cloth, which increases delivery in a cleanly condition. In stowing, particular care is observed to obtain density of load and thus prevent oscillation on suspended hooks as well as mutilation.

Allusion has been made to the fact in many instances the service of re-icing a car en route is rendered by branch establishments of the shipper, but where necessary for the transportation company to perform this service. it is necessary for specific instructions to be given looking to re-icing with salt in cases of fresh meat shipment, along the line of travel at each twenty-four to thirty-six hours distance : the frequency of this re-icing depending, of course, upon the outside temperature and seasonal changes.

Schedules for the transportation of fresh meat and packing house products are arranged with attention; first, to despatch, and it is not too much to claim that the maintenance of these schedules as now arranged under American practice is meeting immediate demands, although it is clear that further expedition in transfer of this property, particularly fresh beef and other meats, to effect delivery as early as possible during the period of progressive improvement in texture and food value — will still further stimulate consumption. This observation relates in a more pronounced way to long distance movements. Further progress may well be made along the line of securing regularity for these schedules, to secure deliveries on regular specified dates, against which the shipper and distributor arrange their stock, or supplies. Effort should be made to avoid delays en route resulting in accumulated deliveries which are disadvantageous to the retailer, who is thus forced to deal with a market one day bare of supplies and the next day over-stocked, and the temporarily stimulated consumption ultimately reduces the volume of traffic carried by the railroad, not only through loss of prestige as a carrier, but through the elimination of a regular uniform consumption, the most potent producer of an increasing volume of traffic.

The maintenance of regular schedules is in certain sections of the United States fairly well assured. Other territories are witnessing the improvement of facilities at terminals, the installation of double tracks, the purchase of additional rolling stock and the adoption of the most improved methods, generally, as they are developed, from time to time. In time, the carrier and the shippers will only have for solution the scientific questions of retarding shrinkage and deteriorated texture of chilled meat, permitting its longer retention in storage, as well as the opening up, through construction of new railroad lines, advertising arrangements, etc., of additional territories of consumption.

A subject to which the transportation lines should address themselves is the handling of cars sustaining injury in transit, suggestions for which have been made

by Mr. D. I. Davis of D. I. Davis & Co., packing house experts, Chicago, Ill., as follows :

Should a car be wrecked in transit, it is not wise to use the first car available marked "Refrigerator," and transfer the contents of the car to it. If the body of the car should have a hole broken in it, the "first aid to the injured" is to close the hole by blankets, quilts or similar means. Keep the car tightly closed, and allow contents to remain in it until a suitable beef car can be obtained. By a "beef" car is meant a refrigerator car that is used in this class of service by the patrons of the road. This car is provided with ceiling racks and hooks for the loading properly of beef. Be it always remembered that not all cars marked "Refrigerator" are suitable for fresh meat transportation. Those unsuitable are relegated to other service, after but a short life as a beef car.

It is of great consequence that any car before the load is transferred thereto, be properly pre-cooled. It will some times require twenty four hours to do this, but the car should be reduced at least to 36° before this transferring is attempted. The contents are a great deal less damaged if allowed to remain in the original car, even thirty-six hours if necessary. The cold stored in the 25,000 pounds of product loaded in the car is a reserve force which helps in these instances.

Another element in successful development of traffic in fresh meat is, of course, export trade, for which the present expeditious Trans-Atlantic service and cold storage compartments in steamships, have rendered available for foreign consumption the chilled meat of domestic production. The end to be obtained by inland carriers with respect to this trade is the appointed delivery to designated steamships and the most expeditious transfer of contents of refrigerator cars to vessels' cold storage rooms. The following quotation from Mr. Davis, briefly but clearly describes this method :

The transferring of the contents from the cars is usually done at night and as quickly as human ingenuity can devise means to do so. The beef and small animals are carried out of the cars, laid on rope nets covered with white canvas. These nets are hoisted by means of the ship's winches, lifted rapidly over the sides and lowered into the holds.

CHAPTER IV.

Dairy products, eggs, butter, cheese and milk.

Taking the list in inverse order :

Milk is probably the most highly perishable traffic offered to the carriers, and the first and practically the only requisite in transportation, according to the best methods in use in the United States, is quick and regular delivery to the consumer. For this reason, a large development in milk traffic over long distances will remain problematic, dependent upon discovery of effective and sanitary agencies to retard or destroy development of fermentation. The tendency of milk to " sour " quickly, has been overcome in some of the continental countries in Europe, by the process of freezing into blocks of ice, and shipping as milk-ice, methods being adopted to agitate the milk during the freezing process, thus providing for uniformity of substance throughout the frozen milk when delivered on the market. The practice in the United States, which has resulted in a very large traffic in the vicinity of consuming markets, such as New York, and Chicago, began under the best methods with the refrigeration, artificially, of the dairy. The description of this method is given in *Ice and Refrigeration*, volume 21, No. 4, October, 1901, page 126 :

> The milk, as it is brought in from the country, is first tested for quality. It is then placed in a large tin tank, from which it passes through three sets of fine silk strainers, which remove all the particles of dirt or dust that may have got into the cans. It then passes through a series of tin pipes, which are submerged in a large brine tank. The tank contains, of course, the ammonia expansion coil, by which the brine is kept at the required temperature. After passing through these coils, the milk is drawn off into cans, which, in turn, are stored in a large refrigerator, kept at a temperature of, say 35°.

Milk prepared by the dairy, as just described, is shipped in two forms of packages, namely, metallic cans and bottles, the metallic cans of 40 quarts capacity, and bottles conveyed in wooden cases partitioned to provide separate space for each bottle, with space between top of bottles and the top of wooden case to permit covering the bottles with ice.

The shipments in metallic cans, which do not permit of tiering in cars, are shipped without ice during cold weather. During warm weather the ice is placed around the shoulders of the cans. Bottled milk or cream is gathered up from station in less than carload quantities, and is iced during warm weather, by placing ice in the cases or carriers around the necks and mouths of the bottles.

The practice of the leading milk handling lines involves the operation of trains on regular schedules, and with passenger train speed : these trains being run on main trunk line for the handling of milk only, with mixed passenger and freight

train service on lateral or branch lines making connection at junction points with solid milk trains. The schedules on branch lines are arranged on basis of about 12 to 18 miles per hour. The main line train is operated with a schedule of about 20 to 25 miles per hour. These services have entended their scope from year to year until at the present time, milk is transported over distances of nearly 400 miles to New York City on a schedule which leaves the shipping point about 8 o'clock a. m. and reaches Jersey City for next morning's delivery at about 12 o'clock midnight. This provides for delivery of milk on the morning after being taken from the cow, or when the milk is about twenty-four hours old. The schedules from nearer-by points permit the shipment of milk taken during the afternoon hours, to secure its delivery on the market in New York next morning.

The following table showing the distances over which milk is carried by various lines into New York will indicate extension in point of distance of the milk-producing territory: these figures were prepared to take in the year 1895, since which time there has been some slight extension of distance on some of the roads; as, for instance, the Erie Railroad is now transporting milk from Cuba, New York, distant 383 miles from Jersey City; the Erie Railroad is now transporting milk a maximum distance of 389 miles; the New York, Ontario & Western a distance of 319 miles; and the Lehigh Valley Railroad a distance of 401 miles.

RAILROAD.	Year.	Town.	Miles.
Erie	1875-1884.	Port Jervis, N. Y.	87
	1884-1886.	Callicoon, N. Y.	135
	1886-1887.	Summitt, N. Y.	183
	1888-1892.	Elmyra, N. Y.	273
	1893-1895.	Hornellsville, N. Y.	331
New York, Ontario & Western.	Prior to 1881.	Summittville, N. Y.	92
	Prior to 1881.	Hurley, N. Y.	110
	1881-1887.	Liberty, N. Y.	118
	1881-1887.	Livingston, N. Y.	118
	1881-1887.	Manor, N. Y.	128
	1881-1887.	Walton, N. Y.	179
	1881-1887.	Delhi, N. Y.	196
	1881-1887.	Sidney, N. Y.	202
	1888-1892.	Randallsville, N. Y.	244
	1893-1895.	Kenwood, N. Y.	264
Lehigh Valley	Carried none up to 1885.	...	...
	1885.	Three Bridges, N. J.	49
	1890-1891 began to extend traffic.	...	...
	1894.	Romulus, N. Y.	335
Lackawanna	Confined to New Jersey traffic up to about 1886, began to extend the traffic in 1886.	...	...
	1889.	Vicinity of Binghampton.	206
	1890-1893.	Extensions continued.	...
	1894.	South Columbia, N. Y.	310
New York Central Lines	1898.	Chatham, N. Y.	127 1/2

The growth of the milk business to the New York market is presented in the following figures, showing the total movement via all lines during the years named :

1886	5,449,612 cans of 40 quarts each.		
1887	5,814,864	—	—
1888	6,021,185	—	—
1889	6,276,084	—	—
1890	7,480,119	—	—
1891	6,932,788	—	—
1892	7,467,987	—	—
1893	7,552,913	—	—
1894	7,738,843	—	—
1895	8,027,040	—	—
1896	8,295,616	—	—
1897	8,628,043	—	—
1898	9,187,127	—	—
1899	9,489,136	—	—
1900	9,811,692	—	—
1901	10,218,169	—	—
1902	10,691,094	—	—
1903	11,425,387	—	—
1904	12,238,443	—	—
1905	13,059,728	—	—
1906	14,510,549	—	—
1907	15,061,079	—	—

The supply of milk and cream for the New York market, including adjoining cities) for the period 1886 to 1907 increased 176 per cent while the increase in the population during the same period was only 98 per cent. Using as a basis, the population in 1886, and the population in 1907, the annual delivered milk supply per capita of the population, increased from about 96 quarts in 1886 to 136 quarts in 1907, or an increase of about 40 quarts for each person. This increase in traffic has been made possible largely through special service afforded by the carrier, supplemented by protection against high temperature by refrigeration.

The passenger train movement outlined above, with an organization known as the Milk Department at point of delivery of the milk, has been contributed by the carrier; it has also contributed to opening up new territories of production, and has thus created a competition, augmenting supply, and stimulating consumption. The Management of a large carrier of milk advises that present methods meet the current requirements of the trade, and that improvements over the present methods of icing milk directly on shoulders of cans and bottles will be difficult to suggest, and expensive to adopt. In the same connection, a further statement is made that the opening of new territory more remote from point of consumption is not advantageous to the carrier and is adopted as a last resort and only when such action is

forced upon a carrier by the action of other milk carrying lines. In other words in the judgment of this same authority, most profitable results are to be obtained by intensifying the milk traffic from nearby points of production, on account of less expensive train service being sufficient and affording more satisfactory deliveries. It must be borne in mind, however, that the cost of producing milk at points nearer the market is necessarily greater than in the more remote sections, which lays upon milk produced on the valuable farming and grazing lands 50 miles of the place of consumption the burden of making a delivered price not greater than that offered by milk produced on the cheaper lands more remote from the market.

However, it would seem to your Reporter that so long as a service can be maintained from the remote territories, with reasonable degree of profit, there exists a duty as well as an opportunity to multiply and improve facilities to the utmost limit of the milk consuming capacity at the market, and thus aid in enhancing the value of additional territorial areas.

The carriers' duty is emphasized by a fact developed in the case of the Milk Producers Protective Association vs. Delaware, Lackawanna & Western Railway, decided by the Interstate Commerce Commission of the United States in 1897, stated as follows :

> A constantly growing demand in New York and adjacent cities cannot be met by Orange County, N. Y., or Sussex County, N. Y., and localities adjoining, if all the milk those districts are capable of producing is supplied. The development of far off milk region has been carried far beyond its natural demands, and a total supply made possible, which is much greater than the current requirements of the cities.

This governmental authority then does the carrier the justice of crediting to their efforts the above results in the following words :

> This has been accomplished through the free icing of milk in transportation by most of the carriers, through solicitations by railway agents and through facilities and other material aid to dealers and others, in the erection of creameries in more distant localities or the occupation of those already built.

Supervision of milk traffic among the more important milk carrying lines is delegated to a milk department, under the general direction of either the general passenger agent or general freight agent; the greater number of roads assigning this responsibility to the general passenger agent, with many of the roads the milk being handled in baggage cars on passenger trains and under a system of tickets covering the transportation charge. The local organization of the Milk Department at principal terminal markets, is described, in one case, as being made up of a milk freight agent, chief clerk, milk solicitor and stenographer, supplemented by a local delivering milk agent, with a force consisting of a cashier, platform foreman, clerks and necessary corps of milk checkers.

The Reporter has confined his observations to the Milk Market at New York, which is taken to be illustrative.

The milk products of butter and cheese shipped in boxes or cartons contemplates, particularly as to butter, the maintenance of a temperature between 30° and 35° : cheese, particularly the type known as American Cream Cheese, requiring mainly cleanliness and reasonably prompt service in delivery. It is true that during the recent past, particularly since the development of the foreign trade, butter is frozen and stored, it having been proven that frozen butter, particularly where it is necessary to store for considerable periods of time, is in much better condition than that which has been subjected to the ordinary cold storage arrangements. Frozen butter should be handled in the usual type of refrigerator car, iced with crushed ice, and 5 to 15 per cent of salt, reducing the temperature to hot exceeding 40°. Butter unfrozen, or in its normal state after manufacture, should be loaded in cars, iced with cake ice, in which a temperature of 45° to 50° is maintained. In colder climates, ice is not necessary during the winter months, although shipment under ice at all seasons is advocated by some shippers, who feel that the presence of ice tends to purify the air in the car.

Existing methods of cold storage for eggs has greatly increased their use, and transportation over long distances. Sound, unbroken, and otherwise perfect eggs, in cases, can be shipped successfully over short distances through the transportation agencies known as express companies, which conduct a package service on passenger trains, and are delivered to consumer in practically their natural state, but the obvious impossibility of supplying large consuming populations from producing territory immediately adjacent, has created two forms of preservation :

One, the transportation of unbroken eggs in their normal state, in cars iced with cake iced, at a temperature of 45° to 50°, to be frozen and stored in a temperature as near zero as may be convenient.

The other method; namely, breaking eggs into tin cans and freezing them, was first adopted by Mr. Henry J. Evans, vice-president of the New York Biscuit Company, who, at the time of his first experiment was using from 30,000 to 40,000 dozen eggs per annum. His plan involved the use of square tin cans, 9 5/9 by 13 inches inside measurement, each holding 5 gallons of eggs, or from 35 to 37 dozen. The can was fitted with a band of strap iron around the top to insure stiffness, also with a tight fitting tin cover, slipping down over the outside of the flange made by the strap iron. The eggs are broken into these cans immediately on their arrival at New York and Western points, and after the cans are filled their contents are frozen solid, and are held in a temperature to maintain this condition until used, when it is found that the eggs have retained their original sweetness and nutritious qualities. This form of egg shipment must be transported in refrigerator cars, iced with crushed ice and from 5 to 15 per cent. of salt, maintaining a temperature of from 35° to 40°, but a lower temperature is not undesirable. There is a small percentage of the movement which takes place is uniced cars, on the theory that the frozen contents will remain in that condition in an air tight car. To secure the exclusion of outside air straw is used around doors and other openings.

With the exception of milk, as described above, dressed poultry demands the greatest attention of all the forms of dairy products. This attention is first and most effectively given in the preparation of the fowl, and in essence, consists of the complete, but gradual removal of animal heat. For this purpose, two methods are in vogue.

One, for shipments known as iced poultry, involves the immersion of the freshly killed fowls in a vat of cool water immediately after killing, this water being changed two or three times during the first few hours up to at least twelve hours, when the poultry is placed in a vat of crushed ice where it remains for twelve hours longer. At the end of this twenty-four hours, the animal heat is entirely removed and the poultry is packed in barrels between layers of crushed ice, in proportions of about two of poultry to one of ice, a large cake of ice being placed on the top; the entire package being covered with burlap. An ordinary sugar-barrel will carry in this way from 175 to 200 pounds of poultry with about an equal quantity of crushed ice. This quantity of ice will depend on local conditions and the distances from market.

The other method of preparing poultry is known as the dry-packed, adopted by the larger and more important shippers in the United States, under which method the animal heat is removed by placing the poultry on racks in a cooling room, where the temperature is held from 32° to 35°; the period during which poultry is allowed to remain in the room varying from twenty-four to forty-eight hours. The poultry is then wrapped in parchment paper, either individually, or by lining boxes and placing papers between layers of fowls. The method of dry-packing has absolutely accomplished the most satisfactory results. As an example of the effectiveness of this method, an instance is cited of a large poultry shipper in one of the Western States who dry-packed and sent poultry to be frozen and stored in an eastern cold storage house, a distance of about 1,300 miles. The poultry was kept in storage for a period of from six to nine months, was sold and re-sold and finally shipped by Express Company in small lots to retail merchants. One box of this poultry was marked with the shipper's name and address, and through error the Express Company returned it in a warm car to the original shipping point. On its arrival, it was examined, and the poultry found to be in fine condition, notwithstanding an exposure of several days after removal from cold storage.

In other instances, poultry is frozen outright after the removal of animal heat. It is frozen solid and will keep an indefinite length of time, in a cool temperature.

Iced poultry is shipped in cars, iced with block ice, without salt, maintaining a temperating of 35° to 45°. Dry-packed and frozen poultry must be shipped in refrigerator cars, iced with crushed ice and 5 to 15 per cent. of salt in which a temperature of 35° to 40° must be maintained.

Pre-cooling of cars for transportation of poultry is an absolute necessity, the desideratum being to reduce the temperature of the car as nearly as possible to the temperature of the poultry. This pre-cooling is accomplished by icing with crushed ice, with from 5 to 15 per cent. of salt several hours before loading.

In loading dairy products, the purpose is to secure safe carriage and allow circulation of cold air in the car. The other essential being that where solid cars of iced, dressed poultry are shipped, the barrels should not be loaded one on top of the other, as the extra weight crushes the poultry in the lower barrels. Mixed shipments of dairy products and poultry should be loaded with the poultry in the end next to the ice bunkers, eggs to be loaded in cases length-wise of the car, boxes and tubs of butter, and boxes of cheese all on top of each other, all properly braced after loading.

Cars of dairy products are concentrated at large forwarding points and handled in solid trains as far as possible to some point where trains are broken up and individual cars forwarded to final destination. Expedited transportation is a necessity, but intelligent and effective refrigeration is of the first importance and will counteract the effect of delays which may occur en route. These methods have been briefly described above. Re-icing is necessary at intervals of twenty-four hours for the maintenance of required temperatures.

An important feature of the dairy products traffic is the operation of so-called " pick-up cars ", pre-cooled by icing to the required temperature, operated from some central point through a producing territory, stopping at designated stations to gather shipments of eggs, butter and poultry. The operation of these cars, while necessary, cannot, of course, prevent disadvantages of varying conditions of the different articles of traffic as delivered at the stations : and the impracticability of maintaining uniform temperature, with constant entering of the car to install the load. These " pick-up cars " are carried through to terminals, where their contents are concentrated into carloads for movement in solid trains where practicable, and by special service. The disadvantage alluded to will be difficult to overcome. The most important step in this direction would seem to be the systematic education of shippers in the best methods of preparing and delivering their property for shipment without the necessity of installing expensive plants : as illustrated, shipments of dairy products, hauled from the country, should not be allowed to stand in warehouses or on station platforms an undue time, awaiting arrival of " pick-ups " as the shipper should become familiar with the schedules and time his deliveries at station so as to avoid what might prove to be injurious detention to his property. To this end, transportation lines and shipper can co-operate : the one by the operation of a regular schedule with reasonably certain arrival hour for trains : the other by adoption of precautions indicated by common sense. The effectiveness of present methods of American transportation of dairy products is shown by the following figures, giving the volume of this traffic passing Chicago, eastbound, during a period of thirteen years.

The methods described above for handling dressed poultry and eggs received additional approbation from the producers of this class of poultry at a town in one of the mountain sections of a Southern State. These methods have been adopted in this section for about seven years, during which time the traffic in dressed

poultry has gone from small shipments at the beginning to a total output of 1,500,000 pounds, during the year 1908, and a total product of 35,000 cases of eggs for the same period.

YEAR.	Butter.	Eggs.	Cheese.	Dressed poultry.
	Tons.	Tons.	Tons.	Tons.
1893	64,130	32,097	9,040	16,251
1894	72,907	44,353	11,904	27,333
1895	84,433	48,116	9,663	27,012
1896	102,849	57,805	8,442	29,818
1897	99,801	55,528	10,144	27,940
1898	97,170	60,129	4,926	30,076
1899	99,649	54,431	5,628	28,375
1900	103,239	65,481	7,726	35,925
1901	108,111	68,111	5,375	39,491
1902	100,648	69,184	5,696	37,218
1903	104,674	73,368	6,922	34,058
1904	106,938	85,286	7,135	37,804
1905	127,024	91,167	7,421	41,456

CHAPTER V.

Fruits and vegetables.

a) *Highly perishable fruits and vegetables.*

The early varieties of vegetables, embracing lettuce, early cabbages, tomatoes, radishes, asparagus, green peas, early onions, egg-plant, string beans, and squash, requiring a comparatively short time between planting and preparation for market, and containing a large percentage of water, quickly deteriorate after gathering. This deterioration occurs more perceptibly and speedily in the form of blight or wilt, which discourages consumption to probably a greater extent in connection with vegetables than with any other from of perishable horticultural products. Deterioration from decay sets up less actively, and is more easily combatable. Care in gathering and packing is of the highest importance in effecting a successful delivery to market. The produce is usually grown by numerous individuals at various way stations, requiring " pick-up " service between terminals where cars are

assembled in trains for long distance movements. In some exceptional instances, market gardens or farms exist of sufficient size to warrant solid car loading : similarly there are frequently a number of stations scattered through vegetable territory where produce is assembled by wagon haul, and loaded in car lots through to final destination. But that form of the traffic which the rail carrier is forced to assemble in small lots, calls for especially thoughtful attention to detail. Your Reporter finds that the service in a territory producing a large volume of vegetable traffic may be described as follows :

During the fruit and vegetable shipping season, we operate over the different divisions as the season is on, what we term " Fruit Pick- Up Trains ". This train on each division leaves the first shipping station on the district somewhere about four o'clock in the afternoon, so that the work of loading the less carload shipments is performed late in the evening, and at many stations after the sun has gone down, and the amount of heat permitted to enter the car while open, is reduced to a minimum. This train picks up the car load, and less than car load lots along the district at all stations, and upon arrival of the cars at the end of the district, they are placed in the through fast freight trains. Each pick-up train carries out of its terminal, empty ventilated cars, and empty iced cars to pick up the less car load shipments. The train carries, in addition to its regular train crew, a man who has charge of the loading of these less car load shipments, and he in turn will have three or four laborers under him to perform the work. The shipments are stowed, and properly stripped as fast as offered for forwarding, at the various stations, and when the train reaches its final terminal, the loading is finally shaped, and securely braced for transportation to destination, or break bulk point. The doors of the iced cars are permitted to remain open only for a time sufficient to load and strip the offerings at each stations and doors are kept tightly closed and fastened between stations. There is less complaint and trouble as to alleged improper refrigeration on these L. C. L. shipments, than on carload lots. The loaders are for the most part men who have been in this line of work in past seasons, and understand what is wanted. It is a rule to separate loadings, that is, one end of the car is reserved for highly perishable commodities, such as strawberries, and the other end is used for miscellaneous commodities, such as cabbage, beets, potatoes, etc., etc. It has been demonstrated that better results are obtained by not mixing the loading, and that the strawberry to properly carry to destination should be loaded in an end of the car by itself.

A variation from the pick-up service performed by rail carriers, as just described, appears in certain coast cities adjoining market garden districts, ramified by salt water inlets and rivers, on which small steamers and other water craft ply between the plantations and wharves at the shipping ports, for the assembling and transshipping of property. Certain wharves are usually assigned especially to vegetables. Despite the crudity of this assembling service and its dependence on tidal conditions in winding water-ways, a large and increasing volume of traffic is being developed. The co-operation of the rail carrier begins by furnishing the wharfage and necessary tracks for transfer from vessel to cars combined with a carefully planned schedule for quick delivery of property to market. Experience in the case

just cited, has shown that refrigeration is unnecessary, although this additional facility could be easily supplied. Thorough ventilation plays the most important part in the successful transportation of vegetables.

To secure immunity from blight and wilting of vegetables, no method so far adopted has proved so successful as shipment in refrigerator cars under ice. There are two commodities, namely, lettuce and green corn, which it is necessary, at certain seasons, to pack in hampers or barrels with crushed ice, giving the produce a fresh appearance at destination. Better conditions of produce at market are to be obtained, according to expert opinion, from the adoption of pre-cooling methods, a discussion of which follows later on.

Early fruits, or more definitely stated, highly perishable fruits, embracing berries, cantaloupes, musk melons, peaches, cherries, plums, and pears, are handled largely under refrigeration in cars cooled before loading, by fully charging ice tanks, — before loading if possible; if not, immediately after loading — with ice broken into irregular pieces, ranging from 25 to 50 pounds each, with enough smaller pieces to fill the vacant spaces. This will require, in a standard refrigerator car, from 8,000 to 9,500 pounds of ice. In the absence of accepted measures for pre-cooling, reliance is placed entirely on icing in advance of loading or immediately after the load is placed in the car. For the maintenance of proper temperature, re-icing must occur at intervals of twenty-four to thirty-six hours; the amount of ice consumed varying with the rapidity with which the load is cooled, and with the outside temperatures. A normally safe temperature is from 45° to 50° Fahr., which, if maintained, will secure satisfactory delivery over maximum distances now traversed by rail carriage, and permit the holding of fruits in efficient cold storage for further extended periods. These three cardinal principles in the fruit traffic, are the guide posts for individual managements to measures and methods necessary to meet individual situations.

b) *Ordinary perishable fruits and vegetables.*

Apples and cabbage, coming under the classification of ordinary perishable, must have protection against heat and cold, according to practice established by experience. The harvesting period for the larger volume of these products is identical, *i. e.*, in the late summer and early fall. From the far Southern sections, cabbage is harvested and marketed during the summer months. There are also shipments of early cabbage from market gardens in the higher latitudes, but the more important movement is that which occurs, beginning in late August and extending through the fall, winter and early spring months.

From the 20 of August to the 1 of November, refrigerator cars without ice are employed in the handling of both apples and cabbage. From 1 November to 1 December, stock and ordinary box cars, equipped with the "A" shaped form in the bottom of the car to provide ventilation, will meet the requirements for cabbage;

ordinary box cars satisfactorily transport apples. From 1 December to 1 March, refrigerator equipment is required for both items to protect against cold weather. From 1 March until the beginning of a new season in late August, refrigerator cars under ice are necessary for protection against heating.

Cabbage is shipped in bulk, with no other special arrangement than the contrivance in the bottom of the car for purpose of ventilation. This contrivance is unnecessary when the cabbage is shipped in refrigerator cars, and during cold weather.

In the early fall a few apples are shipped in bulk, and where the car contains different kinds of apples, ordinary wooden bins are provided to keep the different kinds separate. During most of the shipping season, however, apples are packed in barrels and tiered into car on sides of barrels.

Custom varies in the use or application of artificial heat in cold weather. In the extreme Northern sections, such as the State of Maine, Northern New York, and the Dominion of Canada, some method for securing artificial heat is a necessity. Further South, however, the large volume of traffic in apples and cabbage, has no other protection against extreme cold than lining the inside of refrigerator cars with heavy paper, and covering the floor with wood shavings.

Shipments of apples and cabbage in refrigerator cars over long distances and through varying temperatures, must have attention en route to secure ventilation when the outside temperature rises to such an extent as to injure the contents of the tightly-shut car, securing this protection by proper opening and closing of ventilators in a matter which has to be left to the individual judgment of employees in charge of the trains. It is fair to say, however, that these products are not so sensitive to cold, that result of neglect of this protection is always immediately noticeable. During extremely warm weather, when icing is necessary, the same watchfulness must be observed in providing this icing, as is the case with more sensitive products.

The white potato is perhaps utilized to a greater extent than any other vegetable : is cultivated with varying success in all sections, and does not require special protection against weather conditions, when shipped in the normal temperature of the temperate zone. It is noteworthy, however, that its production in greatest volume and with greatest profit, has taken place in extreme Northern latitudes, and has been made possible entirely by the building of railroads and furnishing of equipment designed to protect against extreme low temperatures. In the North-Eastern portion of the United States, lies a section which was a practically undeveloped timber tract, until the construction of a railroad about fifteen years ago, which traversed this section for 200 miles, including 60 miles of cultivated agricultural country. There had been prior to that time some cultivation of white potatoes, and the shipments had amounted to 40,000 bushels, greater production having been discouraged by lack of transportation facilities. Upon the completion of the railroad, and as a result of a campaign of education in the raising of white potatoes, the campaign being conducted by the railroad, collaborating with the Agricultural Department of the State University, a marvellous increase began in the succeeding

year in potato production, which is reflected by the following figures, giving the shipment of the railroad in question.

1894	1,500,000	bushels.
1895	1,600,000	—
1896	2,400,000	—
1897	1,300,000	—
1898	2,600,000	—
1899	2,900,000	—
1900	3,000,000	—
1901	4,500.000	—
1902	3,100,000	—
1903	5,300,000	—
1904	6,700,000	—
1905	7,700.000	—
1906	12,300,000	—
1907	6,000,000	—
1908	15,000,000 to 18,000,000 (estimated).	—

With the growth of the production has come an extension of area devoted to this crop. The railroad when completed traversed an agricultural belt 60 miles in length; at the present time, potatoes are shipped from 300 miles of the length of this road. A further effect of this development is a substantial increase in the value of farm lands, and greater prosperity for the owners.

The special facilities which have been demanded, consist entirely of artificial heating arrangements in freight cars. Temperatures during the winter are very low, averaging, according to expert observation, 15° to 20° below zero. The shipping season extends from the middle of August until the middle of the succeeding May, and with relation to the forms of protection employed for potatoes, is divided as follows:

From the middle of August until the middle of October, ordinary box cars are used, the side doors being left open about 3 inches and cleated in that position to furnish ventilation.

From 15 October to 1 December, shipments are made in box cars, lined inside with boards and paper.

After 1 December, until the beginning of moderate weather in the following spring, it is necessary to supplement the lining of cars by the installation of a stove within the car, at the expense of the shipper and supervised en route by an attendant who is employed by the shipper. Some shippers in preference to these stove-equipped cars, use cars fitted with patent heaters under a tariff of charges

payable to the owners of these patent cars, covered by the latter's guarantee of safe delivery of the property with certain reservations.

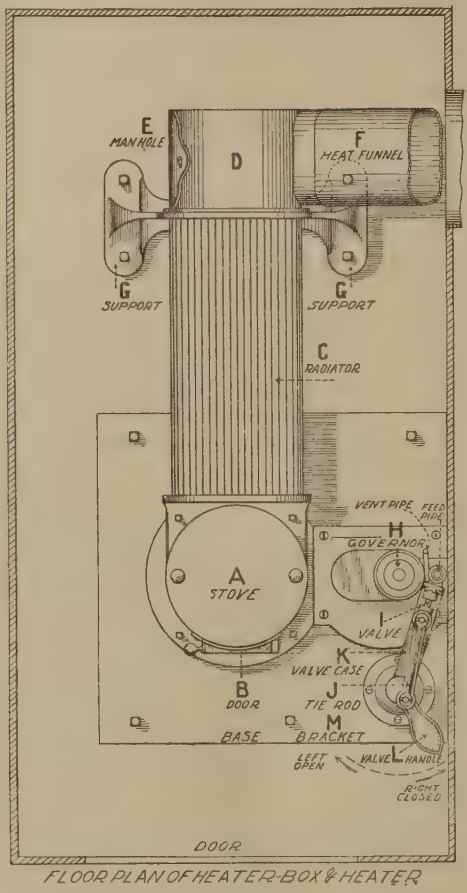

Fig. 8.

One of these patent heater cars is described briefly as an ordinary box car with hollow walls, constituting an air chamber surrounding the load: car equipped about the center of the car underneath the floor with a heater, the floor plan of which (fig. 8) shows a generator of heat in stove A, a radiator of heat C, and a distributor of heat through the ventilator F to the hollow wall of the car. The distinguishing feature of this device is its automatic action. It uses oil as a fuel, is wickless, and the supply of fuel and amount of heat are automatically regulated by

the outside temperature. The fires are lighted at point of origin and require no further attention throughout their movements to prescribed destinations, the most remote being 800 to 900 miles from point of origin. The tank carries 50 gallons of kerosene oil, fire-test 150 or better : oil furnished by the owner of the car. Cars contain no inside obstructions, and for return movement, will be loaded with ordinary freight. Under prevailing custom, they are placarded with the name of the shipper to whom they must be returned. The transportation lines through system of rules and instructions secure the return of these cars as placarded. The latest improved type of these cars has a capacity of 60,000 pounds with a length of 34 feet. Very detailed instructions are given to shippers by the owner of the car, designed to insure intelligent manipulation of the heating device. The following instructions apply to the heater illustrated above.

All parts of the heating apparatus which agents and shippers will have to handle, are designated by letters on floor plan of heater box and heater (fig. 8). For convenience a list of lettered parts is given below, with the letter representing each particular part on the left :

A . . . = Stove or heater.	H . . . . . = Governor.
B . . . = Door to heater.	I . . . . . = Valve.
C . . . = Radiator.	J . . . . . = Tie rod.
D . . . = Radiator end casting.	K . . . . . = Valve case.
E . . . = Manhole for cleaning.	L . . . . . = Valve handle.
F . . . = Heat Funnel.	M . . . . . = Bracket.
G . . . = Supports.	

To light the fire, swing the valve handle, L, to the left as far as it will go, then open heater door, B, and watch for the oil to flow into the base of the circular burner. As soon as the oil can be seen in burner, swing valve handle, L, to the right as far as it will go. Light the oil with match or torch, and wait for the flame to burn all around the circular burner, then for the second time swing valve handle, L, to the left as far as it will go. At this stage of the operation, see that the heater door, B, is fully closed, then close the heater box door.

The fire will regulate itself after being lighted. Do not try under any circumstances, to regulate the fire by placing the valve handle, L, in any particular position, because regulation of the fire by such means is simply impossible. Governor, H, will take care of the fire.

If the oil does not flow to the burner within a reasonable time after valve handle, L, has been moved to the left, as far as it will go, the reason it does not will be due to one of the three causes, namely : because there is no oil in the tank, the feed piston has become clogged, or on account of the oil having become congealed in the governor and pipe connections. In case of congealed oil apply a lighted torch and warm the governor and pipe connections, very slightly, as only little heat is required. Too much heat would be likely to cause leaks and make trouble.

To extinguish the fire swing valve handle, L, to the right as far as it will go. If the draft is too strong when fires are being lighted, partly open the heater door, B, to decrease the draft. If the heating apparatus is found out of order, shippers must not attempt to remedy the difficulty. Report the car as being out of repair to this Company's nearest Agent. It

is *not* expected the difficulties above referred to will occur only in rare and extreme cases.

Shippers must not tinker with heaters that are not in working condition. Report such cars to this Company's nearest Agent.

Cars thus equipped are not permitted to move beyond certain territories of destination: for example, cars in use by the Maine potato trade, are not permitted to move into the Southern States, and rarely move to destinations South of New York City.

These potatoes from Maine are distributed over areas as remote as the State of Texas: they are shipped in large quantities to the Southern States on the Atlantic seaboard: to interior points the movement is all rail, and to handling markets such as Boston and New York, where especially equipped cars are released and returned. Potatoes for long distance movements are usually shipped in sacks, facilitating transfers and protecting the product. Cars equipped with stoves, as first alluded to, are returned to the shipper, who installed the special equipment, in the same manner as the cars containing patent heaters are returned. The regulations adopted by an interested Railroad, governing the location of stoves in cars, as well as placarding for return of same follows:

There must be a sheet of galvanized iron at least forty-two (42) inches by thirty-two (32) inches securely nailed to the car floor. The stove must be securely fastened to the car in the center of this sheet of galvanized iron. There must be on this sheet of galvanized iron at least one (1) inch of ashes or earth under the stove. There must also be at least four (4) inches of ashes or earth in the bottom of the stove.

All wood work within less than thirty (30) inches of the stove must be protected by sheets of galvanized iron.

The stove pipe must pass through a metallic collar in the car door, or in a fire board that allows of at least one (1) inch space between the funnel and the wood work. The stove pipe must be at least thirty inches below the roof of the car, and securely fastened.

Outside the car, the stove pipe must be turned and must project up at least six inches and not over twelve (12) inches above the eaves, and must be exactly one (1) inch distant from the eaves. Stove pipe not to be over six (6) inches in diameter.

No holes shall be cut in car doors, where holes have not already been cut and proper protection furnished by the Railroad Company, owning the car.

The rules and regulations with regard to return boards are modified as follows:

While a return board of a size not exceeding eighteen (18) inches by thirty (30) inches is permitted, one (12) inches by twenty-four (24) inches is a much better size, and is recommended. All notices for return of cars must be on boards painted white, with the name of the party to whom the car is to be returned stenciled or painted in black on the white board, and should read similar to the following:

RETURN TO
JOHN DOE, HOULTON, MAINE.
Via. . . . . R. R.

Nothing whatever in addition to this can be permitted

Hereafter these return boards must be placed one on each side at the lower edge of the car over the bolster, on that end on which the number is painted, care being taken to see that it is not placed over the dimensions or tare of the car.

Return notices printed on paper or cloth and tacked onto the sides of the car with pieces of laths or boards around the edges, will not be permitted.

Station Agents and Car-Inspectors must see that these rules are strictly complied with.

As pointed out above, an attendant is necessary for these cars, who is employed by the shipper. This individual having in charge a maximum of five cars is given free transportation to destination of the cars, and is then returned at a special passenger rate to point of shipment.

Rentals are paid for the patented cars to their owners, varying from $12·50 per month to sums ranging from 15 to $25 per car per trip. These rental charges cover the use of the car, the service of attention en route, and the guarantee, under certain restrictions, of safe delivery. Expert opinion pronounces the devices now in use as adequate to the present demands and capable of caring for future developments within limits which may reasonably be anticipated. These observations are reported for benefit of Managements who have to deal with extremely low temperatures in the winter season.

Improved ventilation, insulation and pre-cooling.

As bearing directly on the transportation of fruits and vegetables, your Reporter will deal below with suggested improvements and with actual experiments, having for their object greater efficiency and economy in refrigeration as well as better condition of load at destination. These improvements seem possible along three lines, namely, ventilation, insulation and pre-cooling.

The employment of outside atmosphere for the preservation of perishables in transit, is attended by such variable conditions as to preclude anything more than general practice. Ventilation, of necessity, cannot be solely relied upon where outside temperature is continuously so high as to accelerate deterioration, and experience already gained by shippers and carriers combined with a general knowledge of the temperature changes to be anticipated throughout a given movement should usually protect against that danger. Dangerously low temperatures will be encountered, and in securing ventilation, great care must be exercised to properly graduate ventilation, as such lower outside temperatures are encountered. Access for outside air to interior of cars is gained in the case of ordinary ventilated cars by openings in the ends or sides, protected by gratings or screens; in the case of refrigerator cars, by opening hatches, removing plugs to ice tanks, and adjusting hatch covers to catch the air which is forced through the car and out through similar openings at the rear by the motion of the train. This latter arrangement has been so satisfactory that the construction of cars ventilated only at ends and sides is giving way to ventilated refrigerators.

Perishables moved under ventilation are either accompanied by attendants employed by the shipper, or are tendered to the carrier with specific instructions from the shipper as to ventilation to be used; or are tendered to the carrier, without instructions, for handling at his discretion.

The Railroad Refrigerator Service Association of the United States in circular No. 27, effective 1 July, 1908, establishes the following general principles to govern the three classes of shipments :

1° Shipments accompanied by messengers, are entirely within their control as to ventilation, and no instructions necessary on billing accompanying such shipments.

2° Shipments to be handled under shippers's instructions for ventilation, must be accompanied by definite and reasonable instructions, which must be shown on bill of lading, way bill, card-bill and transfer receipt; any of the following notations being acceptable :

" Standard ventilation,"
" Keep ventilators open to destination,"
" Keep ventilators open to. . . . . ." (See note.)
" Keep rear ventilators open to destination."
" Keep rear ventilators open to . . . . . ." (See note.)
" Keep ventilators closed and plugs in to destination."
" Close ventilators and put plugs in at . . . . . ." (See note.)
" Close front ventilators and put in front plugs at . . . . . ." (See note.)
" Open one (or two) side-door for ventilation at . . . . . ." (See note.)
" Side-door not to be opened for ventilation when temperature is below freezing (32°) ".

Note. — No points other than regular icing and inspection stations to be inserted.

3° Shipments entrusted wholly to the discretion of the carrier must not be moved except on waybills, card-bills or transfer receipts, which carry ventilation instructions. In the absence of authoritative instructions, perishables under ventilation will be governed by " Standard Ventilation Rule ", which reads :

Put in ice-plugs, close hatches and (other) ventilators when the temperature falls below freezing (32° Fahr.). Open hatches and ventilators and take out ice-plugs immediately the temperature rises above freezing.

Detailed rules, working out these general principles are enforced, although their successful application, and the satisfactory accomplishment of a movement under ventilation, seems to depend on the carrying out of the further following general rule:

Agents, conductors, inspectors and other employees in charge, must examine waybills covering perishable freight under ventilation, frequently determine temperatures, and examine all ventilating devices to see that they are set in accordance with instructions as governed by temperature. On account of temperature rapidly rising and falling during day and night, variations account of altitude, etc., conductors are especially cautioned to observe this rule and change the position of ventilating devices, whenever they are found to be at variance with waybill instructions. Make careful record of all changes made in position of ventilator and other devices, stating time and temperature, or other reasons for action.

These general rules of conduct are in successful operation on lines, members of Railroad Refrigerator Service Association, traversing territories reaching from California across the Rocky Mountains and arid Western plains to the humid sections of the Middle, Northern and Eastern States. They result from the intelligent observation of climatic and atmospheric changes by subordinates in actual charge of property, and in the opinion of your Reporter, can be made more successful only by education of these subordinates to still closer observation, of the existing natural condition of high and low temperature.

Ventilation which removes accumulated gases and heated air in the top of the car has not been entirely accomplished, and the suggested adoption of a device known as the Garland ventilator deserves the consideration of managements. This device is constructed on the exhaust or suction principle, which is designed to draw out the warm air and gases, permitting cool fresh air to flow in through the ordinary ventilators to reach the upper portion of the load, and in the cases of traffic under refrigeration, to permit the cold air to fill the space hitherto occupied by the warm air and gases. Moreover, in the case of shipments moving in ventilated refrigerators with the ventilators closed, because of too low an outside temperature, this Garland device sucks out the bad air and gases which form.

Figure 9 shows the base plan of the Garland ventilator.

Figure 10 shows the ventilator attached to the roof of an ordinary refrigerator car.

Figure 11 shows the side elevation, and

Figure 12 the end elevation of the device.

A study of Figure 9 shows the principle to be that of exhaustion or suction from the interior of the car through the opening from the car (XY) into the vent W, brought about by air forced by rapid motion of the train into the duct X'Y' past the mouth of the vent W connecting with the interior of the car. The arrangement of the ducts (X'Y') opening in opposite directions provides for movement of car in both directions. Tests of this device have shown that at a speed of 30 miles an hour, 10,000 cubic feet per hour is drawn from the car. Reckoning the cubic contents of the car as 2,000 cubic feet, one ventilator would exhaust the contents five times per hour, or once every twelve minutes; by increasing the number of ventilators to two, the exhaustion is twice as great. It is obvious that provision must be made for the inlet of an equivalent amount of fresh air, which is provided as above suggested, by leaving the ordinary ventilators open during seasonable weather, and in cases where the ventilator cannot be left open, and the exhaustion from the Garland ventilator cannot be omitted, regulation is had by a damper at the inner end of the opening next the car. In case of property handled under refrigeration, the Garland ventilator provides for the permeation of the cold air throughout the entire car up to the roof, and when cars are not in motion, an intake of warm air is prevented because of the denser interior atmosphere. On the other hand, in case of movements under ventilation with vents closed, because outside temperature is injuriously low, the damper or regulator at the inner end of the car vent can be closed,

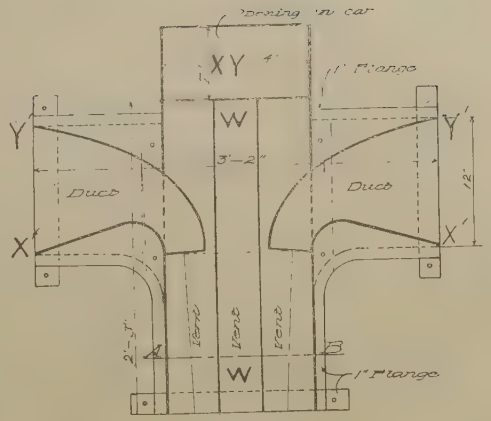

Fig. 9.

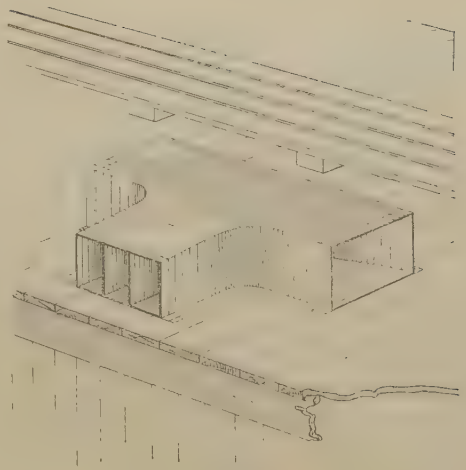

Fig. 10.

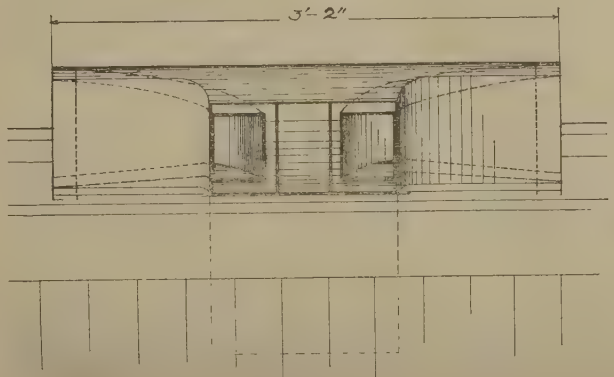

Fig. 11.

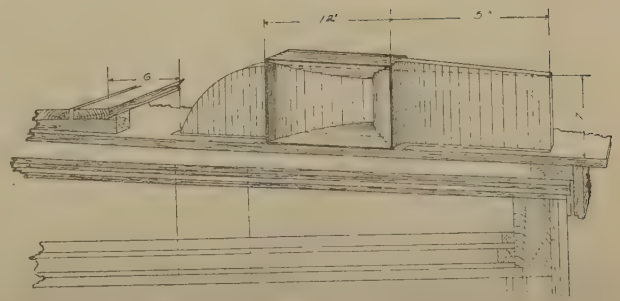

Fig. 12.

and prevent the admission of cold air. This device tends to procure equality of temperature throughout the car, which has been proved by actual test : as for example, a carload of strawberries shipped from Quincy, Ill., to St. Paul, Minn., in June, 1907, was found on opening to contain a temperature of 37° Fahr. at the ceiling, with the berries in the center of the car in as good condition as the berries at the end of the car next to the ice bunkers. The practical result of this test is appreciated, when it is borne in mind that the ordinary difference in temperature between floor and ceiling in a car under ice is from 15° to 25°. On a carload of peaches from Grand Junction, Colo., to New York City, equipped with a Garland ventilator, the difference between the floor and the roof was only 9°. The tests cited were conducted with cars and loads such as are ordinarily handled under refrigeration, and while the effectiveness of the device cannot be said to have been definitely proved, there is a clear suggestion of possibilities of improved condition of air in the upper part of the cars, permitting increased loading, with better revenue results, as well as a reduction in the number of cars required to conduct the traffic in perishable freight.

What is said above with regard to ventilation for gases and heat has been suggested by the handling of vegetables, but applies with equal pertinency to all classes of horticultural traffic, which is to be handled under ventilation or refrigeration.

Improved insulation, with its anticipated results of saving ice and better protection for fruit, is not accomplished without some loss of efficiency, either through increased dead weight or reduced cubic capacity. The latest experiment along this line has been conducted by the Pacific Fruit Express Company, collaborating with Mr. Bohn of St. Paul, Minn., its conduct and result being thus briefly described by Manager Secrist of the Pacific Fruit Express :

Two cars, one a standard refrigerator car, the other a standard refrigerator, fitted with six, instead of two layers of linofelt, were loaded with oranges at Harod, California, 6 October, 1908 : pre-cooled at Los Angeles, 7 October ; and moved east from Los Angeles, 5·35 a. m., 8 October.

The cubic capacity of the standard car was 2,059·45 cubic feet : of the improved car 1,851·18 cubic feet, or a loss in capacity of 208·27 cubic feet. This loss was shown, practically, by the ability of the standard car to accomodate 396 boxes standing on end, two tiers high leaving a free space to ceiling of car 59-½ inches with air space surrounding the entire load 4½ inches, while the improved car could only accommodate 372 boxes standing on end in tiers, the remaining 24 boxes being stowed on top of the load, lying flatwise, leaving only 18 inches from top of load to ceiling of car, and only 3½ inches air space surrounding the load. Each car was iced before leaving Los Angeles and re-iced seven times en route to Chicago. They reached Chicago with practically the same amount of ice in the bunkers, but with a saving of more than a ton and half of ice by the improved car, as shown by the following :

	Standard car.	Improved car.
Total ice used	22,035 lbs.	18,410 lbs.

Thermometers and a thermograph effectively placed but well separated in car and fruit, gave the following results as to temperatures of air, in the car and of the fruit.

Air temperatures in car.		Average of fruit temperature.	Where taken.	Date and hour.
Top.	Bottom.			
			Standard car.	
...	...	64·57	(Before pre-cooling) Los Angeles, Cal.	7 October, 2 p. m.
...	...	50·78	(After pre-cooling) Los Angeles, Cal.	7 — 6 —
55	47	49·4	Yuma, Arizona.	9 — 5.15 a. m.
52	42	48·7	Tucson, Arizona.	10 — 12.30 —
52	40	48	El Paso, Texas.	11 — 2 —
49	39	46·5	Del Rio, Texas.	12 — 6 —
49	39	43·3	New Orleans, La.	14 — 11 —
47	39	43	Mounds, Illinois.	16 — 6 —
47·5	38	42·14	Chicago, Illinois.	17 — 8 —
			Improved car.	
...	...	68·4	(Before pre-cooling) Los Angeles, Cal.	7 October, 7.45 p. m.
...	...	51·3	(After pre-cooling) Los Angeles, Cal.	7 — 11.45 —
50	42	50·7	Yuma, Arizona.	9 — 5.15 a. m.
49	42	50·7	Tucson, Arizona.	10 — 12.30 —
47	41·5	48·7	El Paso, Texas.	11 — 2 —
45	40	47·35	Del Rio, Texas.	12 — 6 —
41	40	45·3	New Orleans, La.	14 — 11 —
40	39·5	44·14	Mounds, Illinois.	16 — 6 —
39·5	39	43·6	Chicago, Illinois.	17 — 8 —

The following thermograph record shows both temperature, outside, as well as inside cars, with the responsiveness of the latter to the former :

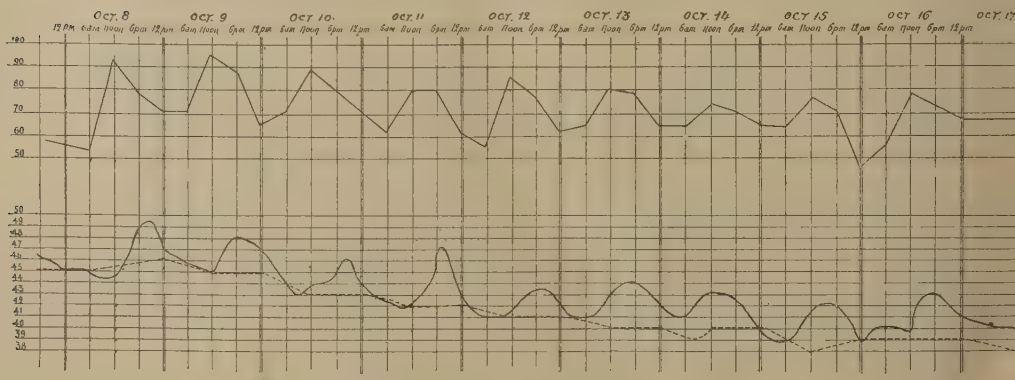

Fig. 13. — Thermograph records Los Angeles to Chicago 1908.

Note. — Heavy black line shows *standard car*; dotted line shows *improved car*.

Mr. Secrist's test confirms the apprehended loss of efficiency in carrying capacity. It further indicates :

« 1° An economy in ice ; 2° A greater depression of temperature in the inside air at the top of the improved car than occurred in the standard car ; 3° A slightly higher average temperature of fruit in the improved car throughout the journey ; 4° Almost an entire absence of response to outside temperatures, by the inside air of the improved car (show by figure 13) which seems to prove the efficiency of the increased insulation. »

While your Reporter has not ascertained whether any attempts are being made to adapt vacuum insulation to the preservation of perishables in considerable bulk in a single vessel, he suggests that if any such attempt has been made, the results might be investigated with success, following out the principle of the " Thermos " bottle, in which vacuum insulation is employed to preserve stationary temperatures in substances of small bulk.

Experiments on the other line, namely, pre-cooling, promise more beneficiary results to all varieties of the fruit and vegetable traffic, than any other measure now attracting the attention of producers and carriers. Tests carefully made by the United States Department of Agriculture, under the direct supervision of Mr. G. Harold Powell, Pomologist, in connection with citrus fruits from California, have shown that the ultimate result is the desideratum of every carrier's effort, namely, the extension of markets. After observing the results of his experiments and expressing his appreciation of the present refrigeration methods, permitting the delivery of perishable fruits and vegetables over thousands of miles, Mr. Powell thus summarizes his general conclusions :

The area over which horticultural products can be distributed in sound, wholesome condition has not passed beyond the early stages of practical development. There are two leading factors that lie at the foundation of a wider distribution of perishable products. The first is an improvement of the methods of handling in the fields and packing houses, in order that the keeping qualities of the product may not be impaired during the preparation for shipment ; the second includes an improvement in the methods of shipment under refrigeration to secure quicker refrigeration of the fruits and vegetables than is accomplished in refrigerator cars, in order to preserve and lengthen their life.

The first mentioned factor must come from the activities of the producer, but the following tables and diagrams are of collateral interest to carriers as an indication of the generous assistance they may well afford to extend Government authorities, and by the dissemination of pertinent literature for the enlightenment of producers. The experiments were made with duplicate lots of apparently sound brushed and un-brushed fruit, sound commercial fruit, and regular commercially packed fruit, and fruit showing visible mechanical injuries, such as stem punctures, clipper cuts,

*

and other types of abrasions. Shipments were made under ventilation and under ice. The following table shows the results under ventilation :

Table I.

TREATMENT OR CONDITION OF FRUIT.	Decay following immediate shipment and approximate delay of 2 days and 4 days.			
	(None.)	(2 days.)	(4 days.)	Average.
	Per cent.	Per cent.	Per cent.	Per cent.
Brushed fruit, apparently sound . .	1·4	2·2	2·7	2·1
Washed fruit, apparently sound . .	1·7	3·7	5·1	3·5
Commercially packed fruit	2·1	4·8	5·3	4·1
Mechanically injured fruit	9·4	15·0	21·7	15·4
Average . . .	3·6	6·4	8·7	

A graphic exhibit of the same results is found in figure 14.

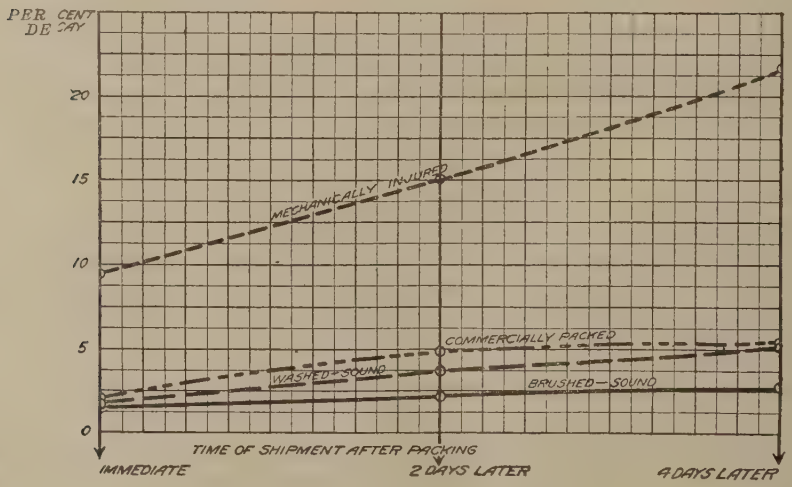

Fig. 14.

Results in connection with fruit carefully handled under commercial conditions on dates beginning in the winter season and lasting until warm weather has begun is shown in the following table :

Table II.

DATE OF FIRST SHIPMENT.	Decay following immediate shipment and approximate delay of 2 days and 4 days.			
	(None.)	(2 days.)	(4 days.)	Average.
	Per cent.	Per cent.	Per cent.	Per cent.
26 February	0·7	0·8	1·3	0·9
19 March	1·8	1·7	1·8	1·8
1 April	1·0	1·9	2·3	1·7
19 April	0·8	1·4	2·7	1·6
1 May	2·7	1·7	2·7	2·4
Average.	1·4	1·5	1·9	

The lessons to be learned by producers from these experiments are thus summarized :

1° Fruit that was handled the most simply, that is, apparently sound brushed fruit developed the least decay, while fruit from the same bins, but injured, in handling developed the greatest amount of decay;

2° Fruit shipped out promptly after packing developed much less decay than that which was delayed before shipment, the greatest injury being apparent in the fruit mechanically injured.

3° Ventilation is adequate protection for fruit during a large part of the shipping season, if the fruit is handled with sufficient care.

Other shipments were made under ice beginning in March and extending to the last of May, 1907, embracing on the one hand fruit which was handled in the groves and packing houses rather roughly, and on the other hand fruit from groves and packing houses in which was exercised more than the average care: both experiments covering sound brushed and washed fruit, commercially packed fruit, and

mechanically injured fruit. These results are displayed in table III, as to the rather roughly handled fruit :

Table III.

TREATMENT OR CONDITION OF FRUIT.	Decay following immediate shipment and approximate delay of 2 days and 4 days.			
	(None.)	(2 days.)	(4 days.)	Average.
	Per cent.	Per cent.	Per cent.	Per cent.
Brushed fruit, apparently sound . .	1·2	3·7	6·4	3·8
Washed fruit, apparently sound . .	2·0	4·2	8·1	4·8
Commercially packed fruit	3·9	8·9	12·6	8·5
Mechanically injured fruit	7·0	18·1	32·4	19·2
Average. . .	3·5	8·7	14·9	...

and table IV as to the carefully handled fruit :

Table IV.

TREATMENT OR CONDITION OF FRUIT.	Decay following immediate shipment and approximate delay of 2 days and 4 days.			
	(None.)	(2 days.)	(4 days.)	Average.
	Per cent.	Per cent.	Per cent.	Per cent.
Brushed fruit, apparently sound . .	1·0	1·8	2·6	1·8
Commercially packed fruit. . . .	1·0	2·6	4·6	2·7
Mechanically injured fruit	7·9	9·0	14·7	10·5
Average. . .	3·3	4·5	7·3	

while figure 15 will present to the eye the same facts, as displayed in table III.

A study of these illustrations cannot fail to impress the intelligent and thrifty producer, and it is not difficult to discern the self-interest, which would induce the carrier to exert itself to see that these facts should be placed in the hands of its ally.

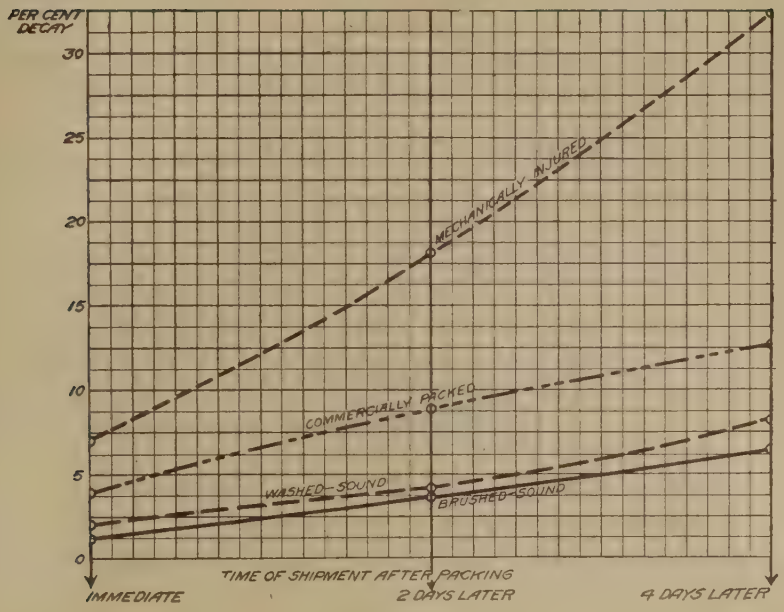

Fig. 15.

The additional suggestion of Mr. Powell belonging wholly in the realm of the carrier has been exploited and portrayed by experiments and illustrations equally instructive. The cooling of fruit before shipment retards the ripening process, checks development of decay and brings about equalization of temperature in the car. Ripening is accelerated by the separation from the tree, particularly in warm, moist climates : hence packing warm fruit in a car, notwithstanding it may have been previously iced and temperature effectively reduced, is followed by a period during which the refrigeration is to be communicated to contents, forcing the warm air to the top of the car, a process so gradual that the car may have covered half of its journey before the safe temperature of fruit is reached. This fact is illustrated by figure 16, showing results on two cars shipped in the same train under ice in May, 1907 : temperature of the fruit being the average of five different temperatures in each car taken as follows : two, half-way between the door and the end of the car; two, in the top tier in the middle of the car, and the fifth in the center of the boxes, in the lower half of the lower tier in front of the door. It is seen that it required practically four days to reduce the temperature of the fruit to the safety point, which temperature was maintained practically stationary to the end of the trip, notwithstanding there were fluctuations in some cases of 26° in the temperature of the outside air.

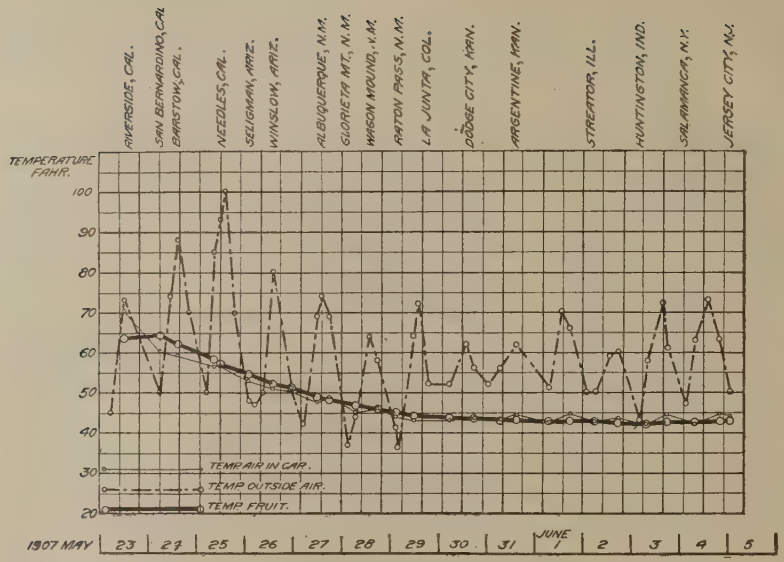

Fig. 16.

Cooling before shipment offers benefits to producers:

1° Ability to deliver fruit to the consumer in state of natural maturity, *i. e.*, the condition in which it would be gathered by consumer located at the point of production; 2° Reduction in percentage of decay and resultant pecuniary loss; 3° Better appearance of fruit and resultant encouragement to consumption; 4° Better keeping qualities after reaching destination, serving to provide if necessary longer time for distribution and preventing unremunerative prices through overstocked markets.

The first of these benefits to producers by pre-cooling is noticed particularly with reference to deciduous fruits, like the peach, plum, cherry, pear, etc., under which the most efficient standard icing methods require gathering before fully ripe, when transportation is to cover periods extending three or four days, reaching consumer insipid in flavor, toughened in texture and sometimes uninviting in appearance. Refrigeration promptly, after gathering, which retards ripening and holds the natural chemical changes in suspense, will remove this serious handicap to the efforts of the producer of these quick ripening fruits, who is widely separated from the consuming markets. Pre-cooling should therefore, be of great value to the deciduous fruit shippers.

The second of these benefits to producers by pre-cooling is very concisely pre-

sented in table V, covering shipment of pre-cooled oranges from California to New York in 1907.

Table V.

TREATMENT OR CONDITION OF FRUIT.	Decay following immediate cooling after packing and a delay of 2 days and 4 days.			
	(None.)	(2 days.)	(4 days.)	Average.
	Per cent.	Per cent.	Per cent.	Per cent.
Brushed fruit, apparently sound . .	0·1	2·3	3 4	1·9
Washed fruit, apparently sound . .	0 8	2 3	5 5	2·9
Commercially packed fruit	2·2	6 2	9 1	5·8
Mechanically injured fruit	3·0	9·2	13 9	8·7
Average . .	1·5	5·0	8 0	

These oranges were cooled to a temperature of about 40° Fahr. before shipment: and duplicate shipments were forwarded in which fruit was cooled as soon as packed: cooled in two days after packing; and cooled in four days after packing. The contrast between the percentages carried in this table and those carried in table III are too convincing to need further comment.

The third of these benefits to producers by pre-cooling closely follows the first two mentioned. Any of the deciduous fruits possessing desirable flavor and quality may be expected to retain their native appearance after allowing for the necessary action of wrappers and unavoidable bruises or indentations received in transit. On the other hand, citrus fruits which are precooled are seen to suffer less evaporation from the skin and present at destination, a round full appearance.

The fourth of these benefits to producers by pre-cooling is so far not fully developed. Mr. Powell's experiments were comparable only with respect to commercially packed fruit handled under ventilation only, and after pre-cooling. These experiments showed that there was a little less decay in the pre-cooled than in the ventilated car on arrival, and the development after arrival was slightly less. Proof was found, however, for the fact that pre-cooled fruit, which in reasonably sound is not more likely to decay after arrival in market, than equally sound ventilated fruit. It is a logical inference, however, that fruit whose ripening process has been so retarded as to secure delivery in approximately native ripe condition, will, if unexposed to varying temperatures, remain in this condition for a much longer period than fruit in which the ripening process may have set up, even for a short time, before being checked by the application of ordinary refrigeration methods. This claim is confidently made for pre-cooling by some of its advocates.

The experiments of Mr. Powell show that the carrier may anticipate advantages from pre-cooling on account of, (*a*) economy in refrigeration in transit, (*b*) increased loading for cars, (*c*) lessening necessity for extraordinarily high and expensive speed of trains carrying perishables without injury to contents.

Figure 17 is the record on a car load of fruit shipped from California under initial icing only, in May, 1906, with marginal table of distances traversed.

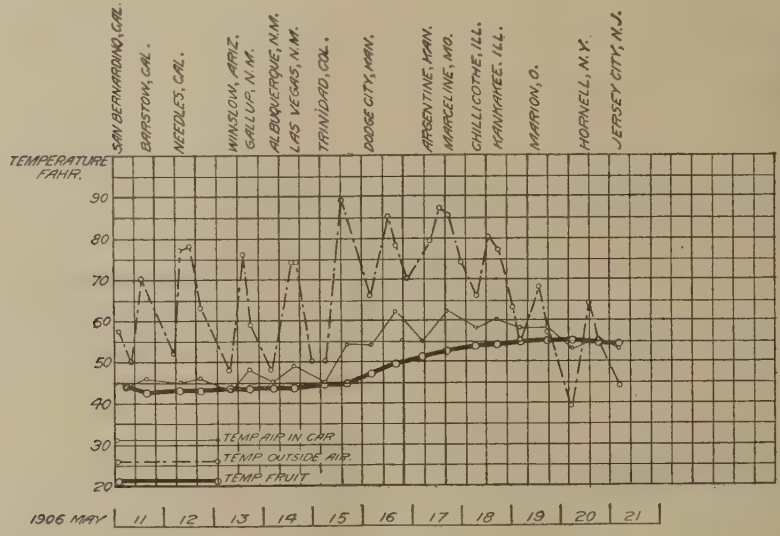

Fig. 17.

Distances in miles from.			*Distances in miles from.*		
San Bernardino,	Cal.	0	Dodge City,	Kan.	1388
Barstow,	Cal.	81	Argentine,	Kan.	1752
Needles,	Cal.	260	Marceline,	Mo.	1863
Winslow,	Ariz.	552	Chillicothe,	Ill.	2081
Gallup,	N. M.	680	Kankakee,	Ill.	2215
Albuquerque,	N. M.	838	Marion,	O.	2527
Las Vegas,	N. M.	970	Hornell,	N. Y.	2923
Trinidad,	Col.	1104	Jersey City,	N. J.	3255

The fruit was loaded at a temperature of 42° Fahr. — the car having been previously iced, It was re-iced before leaving California, receiving no further refrigeration, and reached Jersey City with about 700 lbs. of ice in the two bunkers. The outside temperatures, although warm during most of the trip, having the counterbalance of cooler night temperatures, did not cause marked increase in the temperature of the fruit until practically summer heat was encountered about half the distance to destination. Then the rise was gradual, with a further indication of

responsiveness to outside temperatures by a tendency to recession, when cooler weather was encountered near the end of the journey. Contrast this record with that shown in figure 18.

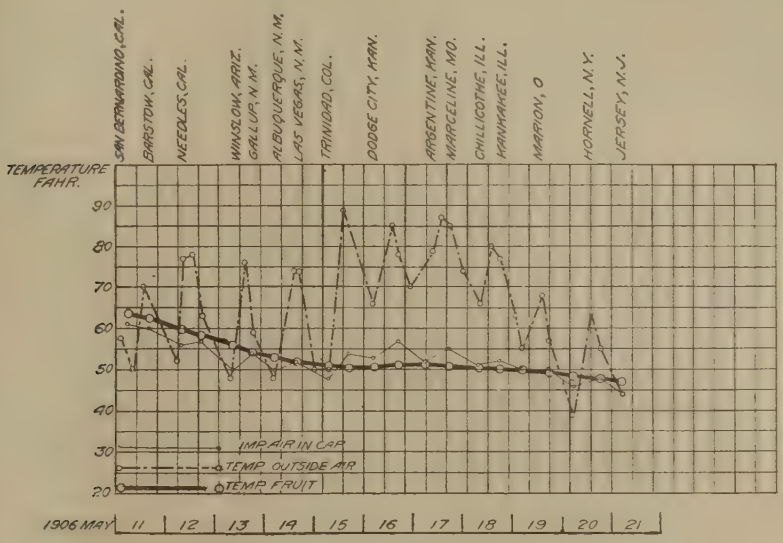

Fig. 18.

of a car handled in the same train, under regular icing, in which fruit, loaded at a temperature 63° Fahr. did not reach a safe and stationary point for four days after movement began, showed responsiveness, although in a less degree, to outside temperature, but did not go below 50° during the warm weather. Bearing in mind table V, previously inspected, which shows from record of percentages of decay, the great advantage of prompt refrigeration after gathering, it may be safely concluded that the condition of contents of the pre-cooled car was much better than of the regularly iced car. It may be further concluded that in the case of this shipment, the re-icing expense at all regular re-icing stations between California and Jersey City — probably seven in number — has been avoided without sacrifice to quality of fruit. This economy may be roughly estimated at from one to two tons of ice per car for each regular station.

It is only proper to report that expert authorities dissent from this conclusion. Mr. J. S. Leeds, Manager, Santa Fe Refrigerator Despatch Company, in a paper recently submitted to the International Congress of The Refrigeration Industries, says:

It has been demonstrated that a car of fruit which has been cooled down to 40° to 45° Fahr.,

and subjected to the same re-icings, as we term standard refrigeration, will take less ice in the re-icings for about five days. Then two cars, one pre-cooled and one not, travelling in the same train will equalize as to temperature inside the car. The natural shrinkage from decay will be less in the pre-cooled car, but the cost of service something more. The saving in ice will not pay for the added expense of pre-cooling.

The statement of Mr. Leeds that temperatures equalize in the two cars receives support by comparing the chart shown as figure 19

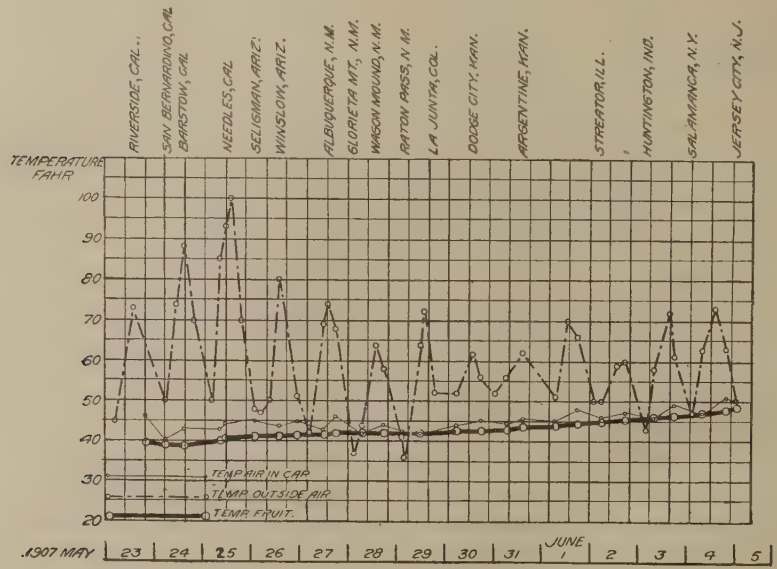

Fig. 19.

giving temperature record of a carload of fruit pre-cooled and shipped under initial icing, only in May and June, 1907, with chart shown as figure 16, giving record on car shipped in same train under regular icing. In these cases, outside temperature was high at the commencement of the trip, retarding action of the refrigerant in the cars under icing (fig. 16) and tending to accelerate rise in temperature of the pre-cooled shipment (fig. 19). It is noticeable, however, that while the drop in temperature in the cars under icing to the safety point required approximately five days, the temperature in the pre-cooled cars did not get above the safety point at any time during the trip, covering a period of twelve and one half days, and shows such gradual rise as to deliver fruit in condition as satisfactory as that of fruit transported in the car under icing where temperature, after reaching the safety point, remained stationary during remainder of the trip — a period of seven days.

Briefly, these charts apparently demonstrate that initial expense of precooling is off-set measurably by saving of refrigerant en route, without detriment to fruit.

The most potent benefit to carrier from cooling before shipment, lies in increased loading of equipment. The system of gravity circulation of cold air from ice bunkers is essentially ineffective in securing uniform temperatures for upper and lower tiers of load. The dense cold air seeking the bottom of the car will gradually cool fruit, and drive heat and gases to the top, where temperatures are, at the end of the trip, always higher than in the lower tiers. This fact is clearly presented by figure 20.

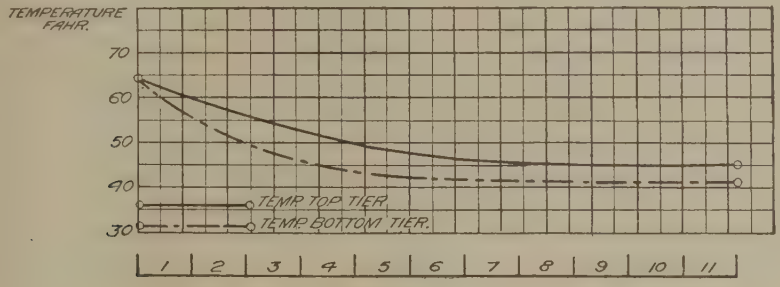

Fig. 20.

The cooling of fruit to a temperature of 40° to 42° Fahr. before shipment, saves refrigerating energy required to expel heat naturally stored in the fruit, and affords a uniformly safe temperature throughout the car from the moment of loading. This permits utilization immediately of a larger portion of the cubic space within the car. Tests have, so far, been applied to shipments of oranges from California, but their results may fairly be applied the other forms of perishable horticultural products.

The method of stowing California oranges for shipment under standard icing regulations, to secure minimum decay in upper tiers, and maximum loading, is shown in figure 21, with two tiers of packages, six packages in each row, standing on ends.

This method provides a load of 384 boxes, at an estimated weight of seventy two pounds each, total 27,648 lbs. The spaces for circulation of air throughout this load occur between the individual packages, with additional space between the outside packages and the walls of the car.

The experimental shipments of pre-cooled fruit were stowed as show in figure 22, with three tiers of packages, seven packages to each of the bottom rows standing on end, and seven packages to the top row laid on the side.

This method provides a load of 549 boxes for the standard 40 foot car, or an increase of 42·9 per cent. This shipment made under initial icing only showed

temperature changes in the three tiers, as indicated in figure 22, with a difference of approximately ten degrees between the top and bottom tiers, and about the same measure of difference between the temperatures in the top tier at the beginning and the end of the trip. While this test shows six degrees greater difference between bottom and top tiers than that presented by figure 21, covering fruit under standard icing, it must be remembered that initial icing only was applied to the pre-cooled fruit, and the conclusion is warranted that with even modified intermediate icing, the difference between temperatures in the top and bottom tiers would have been lessened, and an increased loading secured, more than compensating for the expense of such intermediate icing. If, however, it should be deemed desirable not to supply intermediate icing for the purpose of reducing difference in temperatures in top and bottom rows, in that case by leaving off the horizontal top tier and confining the load of two tiers, each seven rows wide, satisfactory results may still be secured. Such method will secure a load of 448 boxes per car, or an increase of 16·66 per cent. under initial icing only.

From these premises it will be seen that pre-cooling secures an increase in efficiency of equipment directly remunerative to carrier and indirectly advantageous to producer, without any increase in dead weight.

Pre-cooling retards the development of decay; it, therefore, lengthens the period within which the fruit may be safely held and presents to the carrier the added benefit of avoiding extraordinary and expensive speed for trains handling the traffic. Improvements in material and construction have for their object the production of cars which will stand higher speed; inasmuch, however, as these efforts tend on the one hand to a much greater cost of equipment, and on the other hand, to an increase in its dead weight, there is an evident limit to such efforts, and the carrier may well give careful attention to the desirability of this pre-cooling feature, which, by rendering traffic less perishable, continues the availability of existing equipment and lessens the risk attending high-speed operations.

A successful pre-cooling device must reduce temperatures with small delay to movement of fruit. Placing it in cold storage involves delay of several days, while subjecting it to a simple blast of cold air, entails delay of from twelve to twenty-four hours.

It would be very expensive, if not entirely impracticable, to provide cold storage arrangements adequate to treatment of the fruit crop, from any given section; on the other hand, the conditions under which the crop is placed on the market will prohibit the detention of even twenty-four hours at shipping point. Experts employed by the United States Government, as well as interested private individuals have, therefore, sought a material reduction in time required for pre-cooling, and results so far commend what is known as the Intermittent Vacuum principle. This principle utilizes the well understood action of air introduced into a vacuum or into a body of air, which has been rarefied by reduction of normal pressure.

Expansion of the introduced air takes place and permeates solids enclosed in the

Fig. 21.

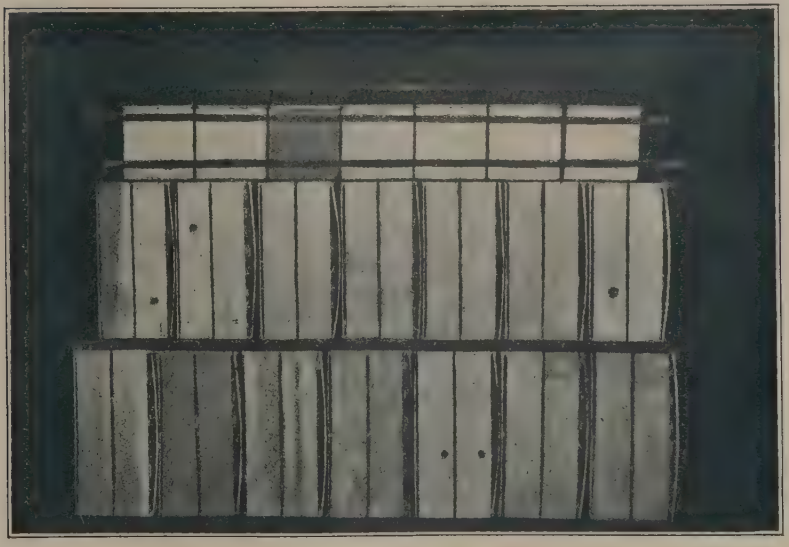

Fig. 22.

vacuum. Following this idea, a car loaded with fruit and tightly closed has, attached, pipes at each end through which the air is drawn by powerful suction: this suction is supplemented by the introduction, through a third pipe attached at top and center of the car, of a volume of cold air, powerfully driven, which, by a distributer, is dispersed in equal volume and pressure to all parts of the car.

A mechanical contrivance intermittently breaks the current of inrushing cold air, creating the needed vacuum, causing the expulsion through suction pipes of warmer air and gases and affecting the refrigeration of fruit to its center to a temperature of 35° to 40°. This is accomplished in a space of three or four hours, while an absolute equalization of temperature within the entire car takes place in twelve hours.

Your Reporter understands that this method has received careful investigation by the Pacific Fruit Express, C. M. Secrist, General Manager, Chicago, Ill., and by the Santa Fe Refrigerator Despatch Co., J. S. Leeds, Manager, Chicago, Ill., in connection with the movement of perishables from California.

CHAPTER VI.

Tropical fruits.

In the list of tropical fruits, the banana and the pineapple are representative and typical owing to their greater popularity and availability as compared with other tropical fruits.

The banana.

While there has probably been for a great many years more or less importation of bananas, as well as other tropical fruits, by civilized countries from nearby tropical regions, the earliest beginning of the present extensive and successful traffic in bananas to the United States may be placed in the year 1872, and accredited to Captain L. D. Baker, of Massachusetts, who sought a return load for his schooner which carried New England fish to the West Indies. The experiment was probably undertaken without serious expectations of profitable results, but the readiness with which he disposed of his cargo, led other fishing craft trading with the banana-producing countries to similar efforts, all more or less under the direction of Captain Baker. Ultimately the Boston Fruit Company was organized, which subsequently became the United Fruit Company. From this fortuitous experiment in transportation, the traffic has grown to the importation into the United States alone, during 1903 of 30 million bunches, or about 3 billion bananas, an average of about forty bananas per annum for each individual consumer in the United States.

The development of this traffic, aside from the thorough organization for produc-

tion and distribution has been ably contributed to by increasingly efficient transportation methods by water and rail.

Whereas, deciduous fruits are notoriously more palatable if gathered in a perfectly ripe state, the banana is improved by being gathered ten days or two weeks before its delivery to consumer in the markets of the United States. The fruit, although green, has attained full growth, and calls for a temperature and humidity which will not check the ripening process. The organization of equipment and forces for supplying the major portion of bananas consumed in the United States, is mainly under the direction of an institution whose ships are especially built and equipped for the satisfactory transportation of the banana. The fleet numbers upwards of seventy-five vessels, in addition to which there are railroads in Central America that reach the banana fields, thus providing for the handling under one system of supervision from field, through port of entry in conjunction with the rail carriers, to markets of consumption in the United States, even to points most distant from the ports of entry. The success of the industry is built mainly on improved methods of transportation, which have sought (*a*) delivery to consumer within the maximum-period of development to full maturity, and (*b*), a constant temperature which while preventing too rapid development and the shortening of time margin for delivery, does not injuriously check the ripening process.

Fourteen days, probably represents the average period within which bananas should be delivered from the grove to foreign consumer. This requirement is now met by short rail hauls to tropical ports, supplemented by fast steam vessel service to ports in the United States and rail schedules beyond these ports averaging from twenty to twenty-six miles per hour. Quick movement by vessel and rail carrier beyond port of entry has been accomplished entirely through complete co-operation from each of these factors in the service; the water carriers contributing vessels built for speed, a thoroughly organized inspection service, both at port of export and port of entry and intelligent supervision of condition of fruit from the moment of its delivery to vessel to its unloading from cars in the interior; on the other hand, the inland carriers have provided extensive and valuable wharf facilities laid with all necessary tracks, and unfailing supply of ventilated refrigerator cars, special attention to other terminal and rail services, especially operated schedules approximating average passenger train movement and special facilities at terminal points en route for re-icing fruit under refrigeration, or affording protection against extreme low temperatures in the outside atmosphere, — all designed to effect handling with a minimum expenditure of time.

Movement facilities may be said to be satisfactorily organized, and further improvements will be needed and anticipated mainly to care for unusual conditions and expanding volume of traffic.

Experience in the handling of the banana supports the conclusion reached as to less sensitive products, that future progress must be expected from measures to secure constant temperatures.

In discussing suitable temperatures for safe storage of perishables, Seibel says :

For bananas, no rule can be made ; the exigencies of the market must govern the ripening process which can be manipulated at will.

While it is possible to regulate the ripening process, experience shows clearly that the banana will blight if subjected to a temperature as low as 45° Fahr., and will reach premature ripeness if continuously subjected to temperature of 90° Fahr. — its sensitiveness to cold probably being the more noticeable. These cardinal points established, the regulation of temperature must begin with very careful inspection at shipside, which culls out the nearly ripe fruit, which is placed on the local or contiguous market for consumption. This loading inspection must be attended by close observation of temperature records inside and outside of car, and followed by inspection of attendant as far in the direction of final destination as economy permits. When high outside temperatures prevail at port, icing is required for long runs, the amount of ice used being determinable by this outside temperature. When outside temperatures at port are low, or approach the danger line, fruit stowed on arrival with more or less natural heat from its tropical origin, is loaded promptly into cars, and all ventilators closed to retain its natural warmth. Where temperatures at port are temperate, *i. e.*, 60° to 65° Fahr., thermal condition of fruit en route is regulated entirely by care of attendant through the use of ventilators, and depends on the expert judgment and skill of the individual attendant.

This description of present methods for securing safe temperature, leads to the query — How may the inevitable fluctuations in outside temperature be off-set and a safe constant provided? This safe constant is given by experts as 52° to 58° — or approximately temperate degree on the Fahrenheit scale, and when called upon to suggest improvements over regulation by ventilation and icing, an officer of a fruit handling company of long experience and expert knowledge, could only propose the installation of devices for mechanical refrigeration and steam heating en route — remarking at the same time that the expense necessary to effect these improvements would hardly be justified by any increase which might be reasonably expected from the adoption of such devices. It is, therefore, beneficial to study measures for increasing the efficiency of the individual attendant and inspector.

To accomplish the result, there is no better method, next to the exercise of care in the original selection, than a system of reports which are subject to verification as to accuracy. Reports devised and adopted by a successfull " banana carrier ", operating steamship and rail lines, as well as marketing fruit :

First. — Of the wharf department (form A, hereafter);
Second. — Of the messenger in charge en route (form B, hereafter).

Call for a minutiæ of information of condition of car, contents and appliances which requirement is likely to secure efficiency from the individual who has to make out this report. The percentage of moisture or humidity in the atmosphere

Form A

Form 1087
15-m 1-8-08

S. S. .....
Voyage No. .....
Kind of Fruit .....
Car Initial .....
Car No. .....

WHARF DEPARTMENT.

Mobile, ... 190

Cargo discharged ..... Wharf
Importer ..... Division
Car started ..... Car finished .....
Temperature in car ..... out car
Car was stowed
Condition of fruit loaded in car.
Quality of fruit loaded in car .....
Was fruit fresh, or old and stale?
Was fruit clean, or scarred and dirty? .....
Was fruit full and heavy or thin and light?
How do bunches average as to size? ..
General condition of cargo
Average quality of cargo...
As loaded in this car up to usual quality and value for this kind of fruit?
Are the false floors properly arranged?
How were the plugs arranged in this car? ...
How were the vents arranged on this car? ...
Was car properly inspected and in good condition for loading?
If so, by whom?
Was fruit unusually warm, heated or moist, or cool and dry?
What time was car taken from wharf?
Remarks .

I personally inspected the loading of this car and the above report is correct to the best of my knowledge.

..... Wharf Inspector

GRADE AND QUANTITY LOADED IN CAR.

EXTRAS	9's	8's	7's	6's	5's	Rej 9's	Rej 8's	Rej 7's	Rej 6's	Reds

I certify that I personally checked the loading of the above car and that this check is correct, also that I personally inspected the car before loading and it was in ..... condition.

..... Checker.

I certify that the above car was carefully and properly stowed and the fruit was in ..... condition.

..... Packer.

APPROVED,

..... Wharf. Supt.

It is absolutely necessary that this Report be returned to the **FRUIT DISPATCH COMPANY, NEW ORLEANS**, *properly filled out. Under no circumstances must this Report be left with Branch House Managers or Consignees.*

Messengers must have their full complement of thermometers also list of consignees who desire telegraphic information when cars are diverted.

Form B.

Form 1004.

Messenger's Report Car.....

S. S.....

Voyage..... Date

Messenger ..... No.

Remarks :

S. S. Voyage Date

Unloaded at Wharf

Car Initial No. Seals

FIRSTS	REJECTS	EIGHTS	SEVENS	SIXES

Stowed Strawed

Temp. Inside Temp. Outside

Train Left Schedule

Front Vents O C Front Plugs I O Seals

Rear Vents O C Rear Plugs I O Seals

Door Seals

Messenger To

Wharf Superintendent

REPORT BELOW UNUSUAL DELAYS, GIVING REASON

STATION	DATE & HOUR	CAUSE

Report below the instructions left with R. R. on leaving car on account of break down.

Station

Date Hour

Condition of Fruit

Position of Ventilators and Seals

Front Vents Op. Cl. Front Plugs In Out Seals

Rear Vents Op. Cl. Rear Plugs In Out Seals

Door Seals

Temp. Inside Temp. Outside

Instructions left with

Messenger

Forwarded via ..... Railroad.

(Show Date and Hour.)

Train.	Arr'd.	Seals Doors.	STATION.	Seals Doors.	Left.	TEMP. In-side.	Out-side.
			O C Front Vents O C I O Front Plugs I O Seals..... O C Rear Vents O C I O Rear Plugs I O Seals..... Ice { F V R V				
			O C Front Vents O C I O Front Plugs I O Seals..... O C Rear Vents O C I O Rear Plugs I O Seals..... Ice { F V R V				
			O C Front Vents O C I O Front Plugs I O Seals..... O C Rear Vents O C I O Rear Plugs I O Seals..... Ice { F R R V				
			O C Front Vents O C I O Front Plugs I O Seals..... O C Rear Vents O C I O Rear Plugs I O Seals..... Ice { F V R V				
			O C Front Vents O C I O Front Plugs I O Seals..... O C Rear Vents O C I O Rear Plugs I O Seals..... Ice { F V R V				
			O C Front Vents O C I O Front Plugs I O Seals..... O C Rear Vents O C I O Rear Plugs I O Seals..... Ice { F V R V				
			O C Front Vents O C I O Front Plugs I O Seals..... O C Rear Vents O C I O Rear Plugs I O Seals..... Ice { F V R V				

Forwarded via.....Railroad.

(Show Date and Hour.)

Arr'd.	Seals Doors.	STATION.	Seals Doors.	Left.	TEMP. Inside.	TEMP. Outside.
		O C Front Vents O C I O Front Plugs I O Seals..... O C Rear Vents O C I O Rear Plugs I O Seals..... Ice { F V / R V				
		O C Front Vents O C I O Front Plugs I O Seals..... O C Rear Vents O C I O Rear Plugs I O Seals..... Ice { F V / R V				
		O C Front Vents O C I O Front Plugs I O Seals..... O C Rear Vents O C I O Rear Plugs I O Seals..... Ice { F R / R V				
		O C Front Vents O C I O Front Plugs I O Seals..... O C Rear Vents O C I O Rear Plugs I O Seals..... Ice { F V / R V				
		O C Front Vents O C I O Front Plugs I O Seals..... O C Rear Vents O C I O Rear Plugs I O Seals..... Ice { F V / R V				
		O C Front Vents O C I O Front Plugs I O Seals..... O C Rear Vents O C I O Rear Plugs I O Seals..... Ice { F V / R V				

Arrived. . . . . , on . . . .

190 P. M. A. M.

Car Initial Car No.

Position of Ventilators and Seals.

Front Vents Op. Cl. Front Plugs In Out Seals

Rear Vents Op. Cl. Rear Plugs In Out Seals

Door Seals

Condition of Fruit

Temp. Inside Temp. Outside

Forwarded Train No. Date Hour

Position of Ventilators and Seals.

Front Vents Op. Cl. Front Plugs In Out Seals

Rear Vents Op. Cl. Rear Plugs In Out Seals

Door Seals

Condition of Fruit

Temp. Inside Temp. Outside

Consignee

Destination

Route

Messenger To

Time held at Hrs. Min.

Examined by

Car Left at Care R. R.

Position of Ventilators and Seals.

Front Vents Op. Cl. Front Plugs In Out Seals

Rear Vents Op. Cl. Rear Plugs In Out Seals

Door Seals

Condition of Fruit

Date Hour

Temp. Inside Temp. Outside

Instructions left with

Messenger

Arrived Destination or Delivered to Consignee's Messenger.

At

Date Hour

Position of Ventilators and Seals.

Front Vents Op. Cl. Front Plugs In Out Seals

Rear Vents Op. Cl. Rear Plugs In Out Seals

Door Seals

Condition of Fruit

Temp. Inside Temp. Outside

Left for Home Train No. Hour

Forwarded via ..... Railroad.
(Show Date and Hour.)

Train.	Arr'd.	Seals Doors.	STATION.	Seals Doors.	Left.	TEMP. Inside.	TEMP. Outside.
			O C Front Vents O C I O Front Plugs I O Seals..... O C Rear Vents O C I O Rear Plugs I O Seals..... Ice { F V ..... R V				
			O C Front Vents O C I O Front Plugs I O Seals..... O C Rear Vents O C I O Rear Plugs I O Seals..... Ice { F V ..... R V				
			O C Front Vents O C I O Front Plugs I O Seals..... O C Rear Vents O C I O Rear Plugs I O Seals..... Ice { F R ..... R V				
			O C Front Vents O C I O Front Plugs I O Seals..... O C Rear Vents O C I O Rear Plugs I O Seals..... Ice { F V ..... R V				
			O C Front Vents O C I O Front Plugs I O Seals..... O C Rear Vents O C I O Rear Plugs I O Seals..... Ice { F V ..... R V				
			O C Front Vents O C I O Front Plugs I O Seals..... O C Rear Vents O C I O Rear Plugs I O Seals..... Ice { F V ..... R V				

Forwarded via ..... Railroad.
(Show Date and Hour.)

Train.	Arr'd.	Seals Doors.	STATION.	Seals Doors.	Left.	TEMP. Inside.	TEMP. Outside.
			O C Front Vents O C I O Front Plugs I O Seals..... O C Rear Vents O C I O Rear Plugs I O Seals..... Ice { F V ..... R V				
			O C Front Vents O C I O Front Plugs I O Seals..... O C Rear Vents O C I O Rear Plugs I O Seals..... Ice { F V ..... R V				
			O C Front Vents O C I O Front Plugs I O Seals..... O C Rear Vents O C I O Rear Plugs I O Seals..... Ice { F R ..... R V				
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			O C Front Vents O C I O Front Plugs I O Seals..... O C Rear Vents O C I O Rear Plugs I O Seals..... Ice { F V ..... R V				

influences the process of development in bananas, and requires intelligent observation and regulation by the attendant. The reports just alluded to do not call for a record of these observations, and, it would seem, might be improved in that respect.

The pineapple.

Traffic in pineapples to interior markets in the United States, in a peculiarly emphatic way, reflects the assistance of an efficient transportation.

Pineapples have been imported by steamship to New York since the establishment of steamship service between that port and the West Indies. Prior to 1901, the fruit was handled in barrels, a type of package which developed a large percentage of decay, owing to the large volume of fruit in the individual package, and consequent weight and crushing of the individual pines. During this period no strong effort was made to trans-ship pineapples to interior markets except through the Express Companies, the consumption being chiefly confined to New York territory. There were some less than car load shipments by the Express Companies of fruit which had been culled from the barrel shipments by steamer. This resulted in a duplication of handling through the distributors both at New York and interior markets, which brought about a price for the individual pineapple in the markets situated in the central part of the United States, so high as to constitute the pineapple an article of luxury. In 1901, the type of package was changed from barrels to crates, producing smaller units and avoiding a large percentage of loss from decay. About the same time, steamship service was inaugurated from West Indian ports to Gulf ports in the United States, which was supplemented by fast freight train schedules from the ports to interior distributing points.

This combination of fast steamship and rail service in addition to making delivery to the Interior Western Markets in possibly two-thirds of the time consumed for movement through New York, eliminated the offices of the intermediate handlers at New York, and the larger Western Markets, and enabled the producer to place his fruit directly into the hands of the distributor at secondary interior markets. This immediately accomplished two results : firstly, — a lowering of prices and encouragement of consumption, and secondly, — increased profit to the producer and augmented production. Pineapples under the former method of transportation and handling, cost the distributor at Chicago approximately twelve dollars per barrel. The same fruit now costs him approximately one half of that figure. The sequel to this condition is that the individual consumer who formerly paid as much as one dollar for his pineapple, can now purchase the same fruit at not exceeding 40 to 50 cents.

Pineapples do not require icing, the movement taking place entirely under ventilation. The trans-shipment at the port is conducted with the same efficiency and rapidity as characterizes the handling of the banana. Although refrigeration is unnecessary, the fruit is loaded in ventilated refrigerator cars to get the benefit of

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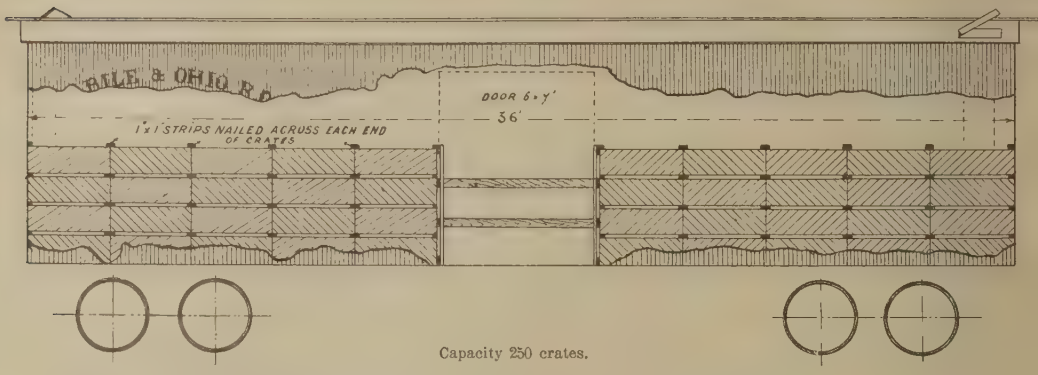
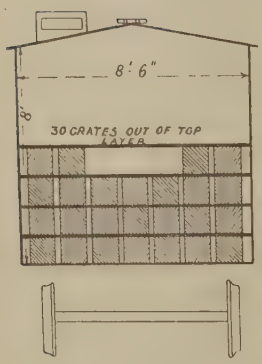
the insulation. The loading is done by employees of the rail-carrier, and the accompanying illustration (fig. 23) gives the details of this loading as practiced at Gulf Ports which is designed principally to secure thorough ventilation.

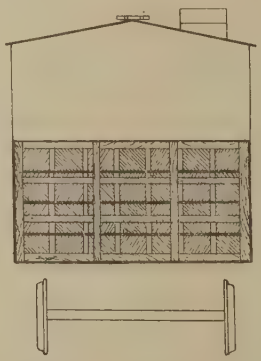


Capacity 250 crates.

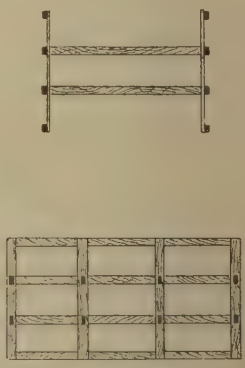
Longitudinal view of car showing method of loading pine apple crates.



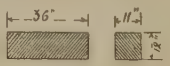
Cross section of loading.



Bracing across car at right and left of door.



Detail of bracing.



Size of crates.

Fig. 23.

Dotted lines show ice box in each end of car. Allowance in loading must be made for same.

The fruit is gathered full grown, but unripe, and is ripened in transit. It is stated by expert dealers that this is a necessity and that the introduction of refrigeration or faster schedules will not necessarily overcome this requirement and

secure delivery of fruit to consumer in its state of natural ripeness. Whether quickened transportation and the improved methods of ventilation and refrigeration, as applied to the perishables, enabling the gathering of the fruit from the stalk in ripe condition and delivery to consumer before material deterioration sets in, will encourage consumption, has not been determined by conclusive experiments. Although, the opinion of one familiar with the trade inclines to the view, that even were it possible to permit pineapples to fully ripen on the stalk, the improvement in texture and taste would not necessarily increase consumption. In answer to a direct question, an expert made the statement that he had no suggestions to make looking to improved rail service; that there was always room for reducing the percentage of decay by more intelligent culture and methods of harvesting, but, in the main, the existing transportation facilities will insure a continuance of the growth of this traffic.

The total importation of pineapples into the United States for a period of nine years, 1900 to 1908, inclusive, given below, allowing for fluctuations in the crops due to varying weather conditions, is strong testimony to the efficiency of existing methods :

Year 1900	341,657 crates.	1,366 cars.
— 1901	344,754 —	1,378 —
— 1902	496,353 —	1,945 —
— 1903	787,369 —	3,149 —
— 1904	646,470 —	2,571 —
— 1905	828,417 —	3,313 —
— 1906	878,962 —	3,515 —
— 1907	637,795 —	2,551 —
— 1908	960,000 —	3,840 —
	5,921,727 crates.	23,678 cars.

As indicating the effect commercially on individual sections, the history of pineapple growing in Florida tells of the beginning of the movement in 1883, when the entire shipment amounted to 5,000 crates; in 1908 it had grown to 690,000 crates, under the same general methods of handling as described above.

CHAPTER VII.

Fish.

The flesh of all kinds of fish is peculiarly sensitive to thermal changes, and is well known to be a form of perishables requiring thorough protection. For this reason, its use in a fresh or uncured state was almost entirely seasonal prior to the utiliza-

tion of the processes of refrigeration, both in cold storage and in transit. At the present time, the markets of every important center and many of the smaller ones carry, daily, a supply of fresh fish of numerous varieties; the blue fish, halibut, uncured cod, lobsters and oysters of the Atlantic Coast, and the pompano, Spanish mackerel, red snapper and oysters of the Gulf of Mexico being as frequently found on the tables of Western hotels and residences, as the salmon, white fish, lake trout, pike and bass constitute an accepted and expected item in the bill-of-fare for residents of the Eastern and Southern States.

This is directly attribuable to methods, which freeze the fish intended for distant destinations immediately upon its removal from the water, move it under refrigeration to destination and hold it — in some cases — for many months in specially constructed cold storage.

The present general distribution of fresh fish in the United States dates from 1830, and has progressed from the plan of cooling in the holds of fishing smacks by ice which was not allowed to come in contact with the fish, through arrangements for stowing in crushed ice and delivery at near-by points, to the present complete processes whereby fish especially sensitive to atmospheric exposure are transferred directly from native waters to freezing rooms in the holds of vessels, frozen stiff before life is yet extinct from other causes and are subsequently delivered to distant markets, retaining all their original flavor.

Attention may here be properly drawn to the fact that, although fresh meats are injured by coming directly in contact with ice, and the refrigerant has to be applied indirectly to shipments of fresh meats; in the case of fresh fish, the best results are obtained by applying the ice directly to the fish.

Supplies intended for near-by markets may require only packing with a proper amount of crushed ice in boxes or barrels, and for such shipments, usually handled by Express Companies on passenger trains, the controlling considerations are distance, season (or temperature) and quantity of ice, which are too variable to admit of arbitrary rules. Although, one large house has suggested the following formula, based upon an approximate temperature of 70° Fahr., throughout the journey.

AMOUNT OF FISH.	12 hours en route.	48 hours en route.
15 lbs.	10 lbs. of ice.	20 lbs. of ice.
25 —	20 — —	25 — —
50 —	25 — —	30 — —

An Oregon firm shipping fresh salmon to New York in boxes 20 by 44 by 12 inches in size, applies 75 lbs. of ice to 175 lbs. of fresh fish from the water; boxes to be

re-filled daily at icing stations en route, at the expense of the Express Company, whose charges include the cost of this re-icing. Under this latter method each car is loaded with twelve tons of fish.

Probably the most successful of existing methods is seen in the shipment of frozen salmon from the fisheries of the Columbia River to New York, handled by the carriers in refrigerator cars. For this movement, the fish are usually frozen solid as soon as caught and piled up like cord-wood until ready for packing. After being dipped in cold water to secure a coating of thin ice and preserve quality and appearance, the fish are wrapped in oil paper with an outer coating of thicker paper and packer in boxes, which are stowed in the refrigerator car, allowing a few inches space between boxes and car walls for saw-dust insulation. The car bunkers are then iced with a mixture of 10 per cent. salt and 90 per cent. ice, which is maintained to destination.

Statistics showing the development of this movement are not available, but the achievement of a successful delivery of fresh fish by refrigerator car over a distance of more than three thousand miles, unquestionably demonstrates its efficiency.

It is equally suggestive of the success of present methods for handling that shell fish are found — in practically every important center on the American Continent, regardless of climatic surroundings; the lobster originating entirely in New England and Nova Scotia, being as well established in the restaurants of New Orleans or St. Louis, as in New York. In like manner, the oysters of the Eastern Coast are to be found alive in the shell in the markets of the Southwest and West.

The annual catch of lobsters on the coast of New England and Nova Scotia is estimated at 6 million pounds, — two-thirds of which is trans-shipped at Boston from fishing craft into facilities for holding and preserving in native state, and thence forwarded by freight service to near-by markets like New York, and by express service to more remote distributing points.

The lobster is shipped in two forms, *i. e.*, alive and boiled, the form of package and preparation being practically the same. During the warm season, about 25 pounds of ice is placed in the center of a barrel, around which the boiled or live lobsters are packed, an additional 25 pounds of ice being placed on the package. During the cold season, no ice is used, except on packages for destinations in the South. This method has been found to preserve a temperature for the lobsters slightly above freezing point, and will carry them safely for a run of forty-eight hours, when re-icing will be necessary, unless outside temperatures are favorable. The packages above described, when for New York market or distribution, are loaded in refrigerator cars, which are not iced, and are delivered by an over night service at 5.00 a. m. arrival at New York. So far, Chicago is the only outer market warranting regular shipment, there being a carload (by Express) daily from Boston to Chicago. It is well to remark that the barrel containing boiled lobsters must be ventilated, and the lobsters salted as well as iced. A large handler located at Boston is unable to suggest improvements, but to the interested carriers, observing the

efforts of the United States Fish Commission to foster and increase the propagation of lobsters, the opportunity for and likelihood of growth in this tonnage, a field for investigation is opened, yielding increased consumption at more distant markets. In the view of your Reporter these investigations should be directed to the handling of this property in refrigerator cars, iced as for fresh meat, if found necessary. It would appear that this might be accomplished by the use of ice — and — salt mixtures, compounded to produce required frigidity. With these measures should be combined movement on fast freight schedules, making deliveries to markets in the Central West before deterioration of the lobster has begun.

Oysters are offered for shipment in the shell or shelled, in cans, tubs and barrels. Experience has demonstrated the success of handling oysters-in-the-shell, packed in barrels, by freight service, not longer than four or five days to destination, if a temperature from 40° to 50° is maintained. Shipments of shelled oysters by rail are most satisfactorily transported to delivery to consumer when enclosed in sealed cans, packed in boxes with ice; if shipped in contact with ice, there is a loss of flavor. Such shipments are handled entirely by Express service under a temperature between 30° and 35° Fahr., and are satisfactorily delivered from the Eastern Coast to the South and to Colorado. Statistics are not in hand to show the full volume of this movement, although its magnitude may be appreciated from the annual shipment of 3,500,000 bushels, weighing 262,500,000 lbs., from Norfolk, Va., alone. Measures for increasing this traffic are not suggested by dealers. While the oyster is less a luxury than the lobster, it must, with the latter, find increased consumption to a large degree through increase of population educated to its enjoyment. These observations should, of course, be considered as applicable to the development of a movement from all oyster producing coasts in the United States.

CHAPTER VIII.

Beer in kegs.

The present large production of beer, which reaches destination in wood, depends entirely on refrigeration applied to the packages. Refrigerator cars, usually owned by the brewery, are necessary. The kegs tiered in the car to meet the requirements of the market of destination, are topped by 2 to 5 tons of ice, according to distance to be transported, with a mantle or covering of straw. Icing is done by the brewery, because of fast service and special attention to movement which is given by carriers. These arrangements are declared efficient by the brewers, with the suggestion, however, that the possibility of detention en route from accident to track, train or car, should be off-set by arrangements by carrier to stop for re-icing and protection of beer

against fermentation. This suggestion is too pertinent to require emphasis, and doubtless the carriers of beer are already giving this suggestion for necessary protection proper consideration. If from any cause, whether from future shipment in car loads to sparsely settled sections not now receiving in carload lots, or on account of other conditions, the haul should be lengthened, proportionately increased care on the part of carriers will be necessary.

CHAPTER IX.

Conclusions.

Results of observation recorded in the foregoing report pertain largely to the physical handling of perishables by the carriers. Organization and improvement of methods for preparing property for shipment, or for regulating delivery into the actual possession of the carrier; and functions of producer and distributor, and are too comprehensive to receive more than cursory reference in this report.

Protection of perishable property by carrier while in its actual possession through ventilation and refrigeration, has become an obligation on the carrier in respect not only to the necessities of producer and consumer, but to the augmenting of its own traffic and a corresponding increase of its revenue and to such extent is this true that in the United States it has become a legal requirement upon inter-state traffic. Vast populations and large movements, both by handlers and carriers, are, at the present time, almost wholly dependent on the successful discharge of this obligation and your Reporter believes his usefulness measured by the extent to which he can suggest improved ventilation and refrigeration methods.

It is to be regretted that as to ventilation and refrigeration requirements with English-speaking Managements abroad, a failure to receive complete information largely limits your Reporter to suggestions based on prevailing North American practice. However, it is not assuming too much to claim the adaptability of these suggestions to transportation requirements in countries whose barometric and thermal conditions approximate those in North America.

The modern ventilated refrigerator car embodies progress to date in equipment for handling all forms of perishables, and the study of further improvements in its construction and employment as a vehicle for perishables should command the earnest attention of all Managements. The Railroad Refrigerator Service Association of the United States, including in its membership some of the most important rail handlers of perishables, has reduced to a single publication the general principles and rules for caring for perishables handled under refrigeration and ventilation. This publication is known as Circular No. 27, under date 1 July, 1908.

Its perusal is commended. The rules laid down in the circular are for use on all lines members of the Association, and your Reporter presents for consideration the desirability of uniform requirements, particularly where movements cover long distances, with two or more separate managements concerned. The afore-mentioned Association has been organized about two years, and some of its members claim that effectiveness has already been demonstrated. If this claim is supported by the results, it would seem to largely justify the adoption of standard, uniform methods of ventilation and refrigeration, as set forth in circular referred to.

Recommendations have already been recorded in connection with observations on each item of the perishable list. Anticipating their recognition by all Managements in respect to all improvements suggested by ordinary prudence and enterprise, your Reporter especially emphasizes the following suggestions on particular lines :

1° *The thorough expulsion of all heat from highly perishable animal and vegetable substances, before shipment.*

The proved efficiency of this principle, as the developer of a greater traffic, demands that all reasonable persuasion or effort should be used to induce shippers to follow it in preparing their property for shipment. Under prevailing practice in the United States, this recommendation will apply most directly to the fruit and vegetable traffic. Pre-cooling by the Intermittent Vacuum process has, apparently, proved a success, and communication with lines who have it in operation as shown in the preceeding report, for future information as detailed operations, cost, results accomplished, etc., is suggested.

2° *The dissemination, among producers and handlers of all classes of perishables, of any and all suggestions of improvement in methods of preparation, packing hours for delivery to carrier, and reasonable provisions against possible contingencies of transportation and delivery to consumer.*

Illustrative of this suggestion, your reporter calls to the attention of Managements in the United States the exhaustive and instructive experiments made by the United States Department of Agriculture in connection with the methods of picking, packing and shipping the California orange, exhibits from which are introduced in the body of this report. The losses from the decay of California citrus fruits have been variously estimated between $500,000 and $1,500,000 annually. Such losses, if continued, will ultimately reflect on the carrier's interest to a greater or less degree, and the positive results and suggestions made in *Bulletin* No. 123, of the Bureau of Plant Industry, United States Department of Agriculture, should be brought to attention of producer.

It must be clear that the transportation expense, or rate of freight, assessed for

the movement of perishables is a potential factor in the process of developing that particular form of traffic. However, the rate adjustment on perishables in the United States, and in other countries assigned to your Reporter, so far as he has been able to obtain information, is chiefly, if not entirely, fixed by commercial conditions.

To have attempted to obtain and set forth the varying commercial conditions in the various countries, or sections of countries, affecting or likely to affect the rates of transportation, while adding voluminously to the report, might not have been illuminating and might not properly be considered embraced under subject XVI, which reads :

Suitable measures for developing the traffic in perishables : packing, refrigerator vans, appliances for keeping temperature constant, etc.

This feature has not, therefore, been discussed.

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APPENDIX.

Detailed list of questions relating to question XVI.

Perishable traffic, or commodities and substances requiring exceptional handling arrangements to off-set tendency to early deterioration or decay, comprises,

Product of animals :

Fresh meat;
Products of packing houses or abattoirs.

Dairy products :

Eggs;
Butter;
Cheese;
Milk,

Products of agriculture :

Early fruits;
Late fruits;
Early vegetables;
Late vegetables;
Tropical fruits;

Miscellaneous :

Fresh fish and sea food;
Beer in kegs.

Managements addressed are solicited for answers to the following questions, with respect to each of the above designated forms of perishable traffic :

Arrangements for handling.

1. Does the above classification of perishables conform to the practice of rail carriers in your territory; if any additions or eliminations, please indicate?

2. Is the traffic in perishables conducted wholly by carriers for their own account; or is it delegated wholly or in part, to subsidiary agencies corresponding to the so-called express companies operating in the United States, if so, to what extent, and with respect to which of the different items above named?

As explanation of this question; it has been customary in the United States for the railroad companies to contract with so-called express companies, for whose account special equipment such as is used for handling luggage is transported on passenger trains, or trains maintaining passenger schedules. Under these arrangements the express companies assume the entire

responsibility for property so transported, issuing receipts therefore, publishing their own tariffs and from these tariffs making agreed payments to the railroad companies for the facilities afforded. Under American practice these express companies transport generally package traffic in early fruits and vegetables, and sea food, and to some extent fresh meat and ice in local traffic. It is assumed, managements addressed are more or less familiar with the practice and arrangements outlined between express companies and railroad companies, in the United States.

3. Do commodities as listed above originate on the lines of the managements addressed; or do they originate in foreign countries and imported by water? If there any imports, please designate the articles or commodities of foreign origin.

4. Describe climatic conditions, that is, extremes of heat or cold which have to be provided against. Is this provision made by means of accelerated transportation, or by measures to insure constant thermal conditions, or both?

Describe briefly schedules or thermal arrangements, (including description of specially designed cars, vans or wagons) with tables, diagrams or plates and photographs giving graphic descriptions of such arrangements, and detailing results obtained.

As a part of this description, outline methods of packing and storing in cars, vans, or wagons, with illustrative plates or diagrams; if any difference in type of cars, vans, or wagons, assigned to different classes of perishables described, and explain necessity for such difference.

5. Do rail carriers own and operate specially designed cars, vans, wagons or other rolling stock used in transportation of perishables; if not, please give brief outline of arrangements for providing such specially designed equipment, with schedule or tariff of extra charges, if any, assessed against such property for such special service, *i. e.*, charges for icing, use of special cars, etc.?

Do present methods of ownership and operation of equipment for perishables meet the approval of the shipping and receiving public?

6. Do carriers maintain any system of cold storage or other equi-thermal depots or warehouses for the holding of perishables? Is such storage conducted for the purpose of insuring satisfactory condition of traffic transported? For example; is fruit or vegetable traffic placed in such storage house for refrigeration preliminary to commencement of transportation, with the purpose of retarding and preventing deterioration? What does experience teach as to the benefits from such preliminary storage and refrigeration, both to carriers and patrons?

Is such storage system maintained for the purpose of aiding producers to prevent plethoric conditions of the market, insuring staple and remunerative prices?

Please outline briefly views as to the extent that such storage arrangements encourage and promote traffic in perishables?

Charges for transportation.

Obviously, charges for transportation of perishable traffic must be computed, having in mind a cheapening of cost to consumer, as well as remuneration to the carrier.

1. Outline as to each of the items classified as perishable, a brief history of the rates or charges assessed, stating the basis on which such charges were first determined, and subsequent changes which have had the effect of increasing the traffic. Give data obtainable from Boards of Trade

or Merchants Exchanges, showing the increase in traffic directly following, and resulting from rate fluctuations.

2. If special facilities in the shape of storage houses, cars, vans or wagons are provided by subsidiary or independent organizations, to what extent have such organizations had regard to promoting traffic in computing freight rates and charges? In other words, have rail carriers had the co-operation of storage companies and special equipment companies in effort to reduce the price of perishables and increase their consumption?

3. Are special forms of bills of ladings or contracts of carriage entered into for the transportation of perishable traffic; if so, please describe briefly the differences between such bills of lading and bills of lading issued for other forms of traffic.

[625 .244 & 656 .235 .7]

REPORT N° 12

(All countries except those using the English language)

By Richard BLOCH,

CHIEF ENGINEER,

ASSISTANT TRAFFIC MANAGER OF THE ORLEANS RAILWAY

The questions in connection with the carriage of perishable goods are very complex, not only on account of the delicate character of these goods, of the special and varied precautions which they require, but also on account of the many different kinds of such goods that there are. In some, such as meat, there is a regular traffic, in others, such as fruit and vegetables, there is a seasonal traffic; some are produced generally, such as farm produce; others again are localized, such as sea fish; some, like milk, are only carried a short distance, while others, such as eggs and fruit, are also carried long distances, and so on.

It accordingly seems that each of these articles or at least each of the chief groups would require a special monograph, and for this reason the list of questions sent to the different railway administrations included twelve distinct groups.

Actually many of the questions are common to several groups; if therefore this specialization were adhered to in the following report, it would become of excessive length, and there would be numerous repetitions; accordingly we give up this division and shall proceed in this report to an examination of the whole, in which we shall not so much recall the general principles which are known to everybody, but rather draw attention to the particular facts and principles which we collected in the course of our enquiry and which may lead to interesting results or conclusions.

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In order however to bring back to memory the questions raised in connection with this special traffic, we add as appendix 1 to this report, the list of questions sent to the administrations; following the general order of this list of questions we shall divide our work into the following chapters :

I. — Traffic.
II. — Tariffs and conditions of liability.
III. — Trains and the acceleration of transport.
IV. — Means of conveyance (such as refrigerator vans, constant-temperature vans, etc.).
V. — Settlement of claims.
VI. — Various measures. Packing, etc.
VII. — Propaganda for the development or improvement of the production.

We then propose to follow this general examination by some summary information about certain interesting items which give rise, on the different railways, to special measures worthy of attention. These are milk, sea-fish and flowers.

CHAPTER I.

Traffic.

The information supplied by the different administrations is of a most varied character; some have had none to give, as they keep no statistics, which is a very astonishing fact for enterprises of so commercial a character; others have given more or less detailed information, as contained in the abstracts of their accounts; some finally seem to have compiled special abstracts for the Reporter, for which he has to thank them heartily.

In the case of some railways, we have been able to complete the gaps in their information from other sources, such as the reports submitted to the shareholders, various pamphlets, municipal statistics, etc.

All this different information is very interesting, but to reproduce all of it in this report would take too long, and we have thought it preferable to make it the subject of a special appendix (No. 2) to which we refer our readers.

The first part of that appendix reproduces all the information supplied, on the subject of their traffic, by the administrations who have sent answers on this point; this information was supplemented, where this was possible and likewise interesting, from other sources. The figures have all been reduced, where this was necessary, to metric units.

The countries are classified according to the more special nature of their import or export traffic.

Finally some information is given, taken from the statistics of the Municipal Administration of Paris, of the food supplies of that large city.

A single glance cast on these different tables shows how little useful comparison can be drawn from this information collected from such varied sources; the gaps in certain countries moreover, prevent us from forming a sufficiently accurate opinion of the importance and progress of the traffic in those countries.

For this reason, in order to be able at least to follow the movements of the international traffic, we have utilized the customs returns of the different countries.

Although there is some uncertainty arising from possible alterations which may have been introduced in the method of compiling these statistics, in the distribution of the goods under various heads, changes which are probably the cause of the sudden variations shown in certain traffics, they however give less incongruous information more easily comparable than the railway statistics; in any case they allow us, better than the latter, to follow the flow of the international exchanges which are specially interesting.

The information so collected from the customs returns of the different countries forms the second part of appendix 2. It applies to the countries of continental Europe; however, although England is not included in the scope of our report, we have thought it necessary to give its principal imports and their extent; the importance of the food traffic of that country is in fact so great, it is a matter of such great interest to continental countries, that is seemed impossible to leave it out of consideration even in a paper limited to the latter.

In spite of the want of homogeneity and of the gaps in the information supplied by the railway administrations, a simple examination of it shows that this traffic in perishables is growing everywhere, the increase varying with the increase in the population, with the degree of prosperity of the different countries; but it is everywhere a very remarkable one.

Leaving out of consideration for the moment the international traffic which will be dealt with later, there are certain goods such as milk and sea-fish, which are very important items in the local or home traffic of the different countries; they give a measure of the great increase in this traffic of perishables, and of the interest connected with it.

Taking milk as an instance, we find in the 11 years 1897 to 1907 that the amount brought into Paris increased from 197,684,620 litres to 307,665,401 litres (43,509,729 English gallons to 67,716,133 English gallons); on the lines of the Berlin Directorate of the Prussian State Railway, the amount increased in the 10 years 1897 to 1906, from 155 million litres to 253 million litres (34,115,000 English gallons to 55,684,460 English gallons). The increase during the same period on other railway systems was :

Saxony State, from	50,500	to	86,500 tons.
Bavarian State, from	35,500	—	101,000 —
Baden State, from	24,500	—	55,200 —
Wurtemburg State (1899 to 1906 only), from	33,200	—	67,100 —

As regards fish, the most characteristic results are given below :

Siberian, increased from.	6,000 tons in 1900 to 15,300 in 1906.
Transcaucasian, increased from.	8,300 — — 1902 — 11,000 — 1906.
Russian South Eastern, increased from. . . .	17,200 — — 1897 — 21,100 — 1904 (and decreased 7,400 tons in 1906).
French Northern, increased from	20,400 tons in 1897 to 44,500 in 1906.
French Orleans (from Brittany), increased from .	12,700 — — 1897 — 20,500 — 1908.
Prussian State (Berlin Directorate), increased from	23,600 — — 1897 — 40,900 — 1906.
Saxon State, increased from.	22,500 — — 1897 — 31,000 — 1906.
Bavarian State, increased from	5,000 — — 1897 — 9,700 — 1906.
Baden State, increased from.	1,400 — — 1897 — 3,300 — 1906.

The administrations have been asked to give their opinion as to the causes to which they attribute these increases; very few of them have answered. Those who have done so have generally attributed this progress to the development of the public prosperity and wealth and to the growth of the population, particularly in towns.

The *administration of the Hungarian State Railway* mentions more especially the replacement of cereal cultivation by market gardens which are more remunerative, and, a fact interesting to record, primarily attributes the development in exports to the intervention of shippers of large quantities, resulting in special rebates granted by the railways.

The *Grand Duchy of Oldenburg* mentions the development of the fishing companies.

The *Bavarian State Railway* attributes the increase in the consumption of milk to the anti-alchoolic movement, and to the combinations of producers selling in common.

The particular attention devoted to such articles of food by the railways (quick transit, specially-designed wagons, etc.) and the reduced rates are also mentioned by some of the administrations as causes of their progress.

The examination of the international traffic which can be made by the help of the customs returns, shows, better than these particular statements and these incomplete answers, the fluctuations of this special traffic; they enable us to investigate them more fully.

In order to exhibit more clearly the detailed results given in these tables of appendix 2, we are going to represent them in a series of curves, accompanied by brief remarks.

We shall in the first place examine the import traffic of consuming countries in order to determine to a certain extent the importance and the progress of the demands on the international markets.

The first two diagrams (figs. 1 and 2) show the progress of the total traffic of all the countries considered; as the English and German tonnages far exceed those of the other countries, it has in fact been necessary to give two diagrams, the first on a reduced scale for those two countries, the second for the other importing countries.

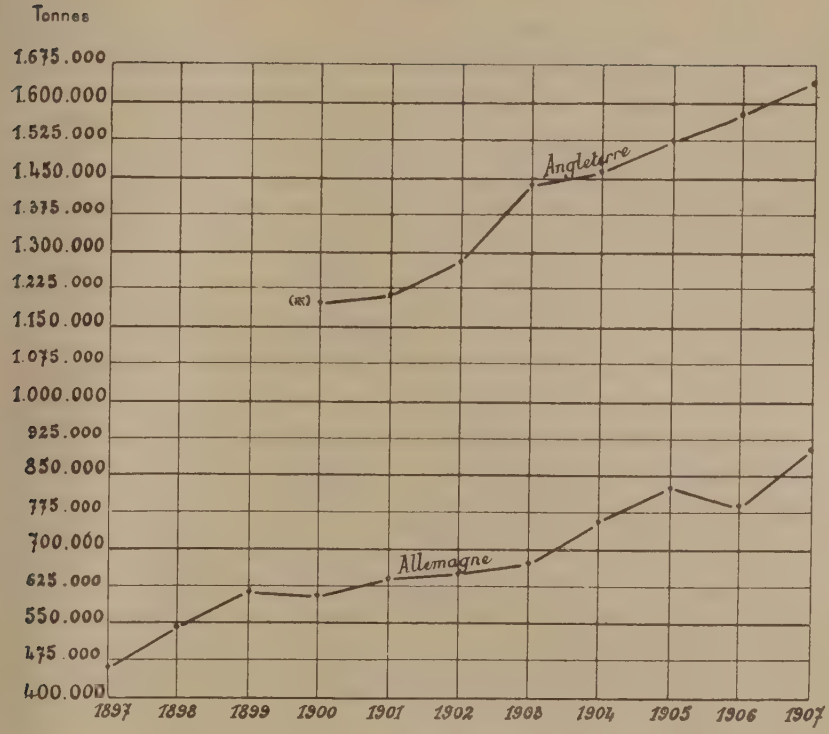

Fig. 1. — Total imports.

(*) Before 1900 the English imports were given in values only in some cases and in volume in others.

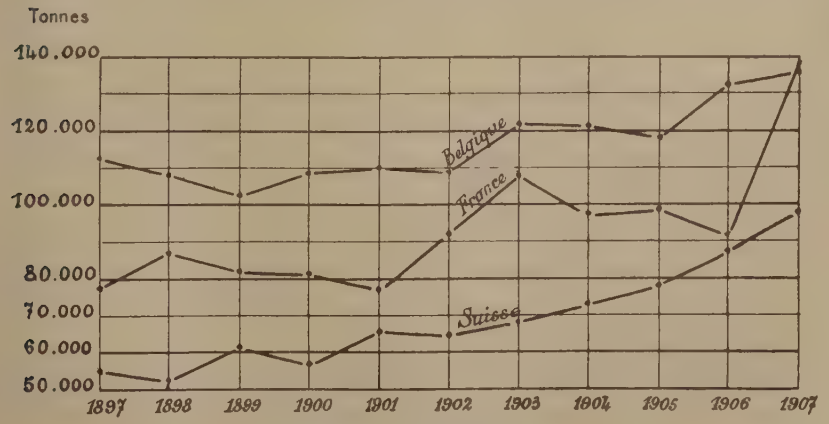

Fig. 2. — Total imports.

Explanation of French terms : Angleterre = England. — Allemagne = Germany. Belgique = Belgium. — France = France. — Suisse = Switzerland.

If we compare the average results of the two last years of the period with those of the two first years, we obtain the differences shown in the following table :

COUNTRY.	Average tonnage of the two years.		Difference.	
	1897/1898.	1906/1907.	+	%
England	1,019,800 tons (1).	1,254,800 tons.	235,000	23
Germany . . .	500,800 —	844,500 —	343,700	69
Belgium	111,100 —	133,700 —	22,600	20
Switzerland	54,500 —	92,400 —	37,900	70
France	82,500 —	113,700 —	31,200	38

(1) 1900/1901.

These curves and the above show the really remarkable increase in the imports into *Germany* and *Switzerland*, increases due no doubt to the industrial prosperity and the growth of population in these two countries, as well as to the continually-growing influx of visitors into Switzerland. This also explains the growing interest felt by the producing nations, principally those on the Mediterranean basin, in their outlets to those two great markets, particularly to the German market which is of course the more important.

In *England* and *Belgium* the traffic has it is true not remained the same, but a period of equilibrium has more nearly been attained.

France, owing to its geographical position, has a double character, being both an importing and an exporting country.

The imports from abroad are often only for supplementary accidental deficiencies in the annual crops; nevertheless a general advance in these imports has to be recorded, an advance due to the increased prosperity and consequently to the growing insufficiency of the home supplies which results from the increased consumption.

After these general considerations, it will be of interest to consider more in detail the progress of the principal items of the general traffic, in order to ascertain which show the greatest advance and which accordingly represent the greatest needs, and consequently attract the special attention of the producers, the merchants and the railways which have to attend to those needs.

The following diagram (fig. 3) shows, from this point of view for the principal continental countries, the progress of the tonnages of our seven groups; a special diagram showing the English imports has been added on account of its interest to the exporting countries of continental Europe (fig. 4).

Limiting our examination to the continental countries, we see that apart from fluctuations due to annual variations in the production, all these traffics are increasing except in the case of fresh meat; the reduction in this is no doubt due to the

protectionist barriers which the different countries erect at their frontiers in order to protect their own produce.

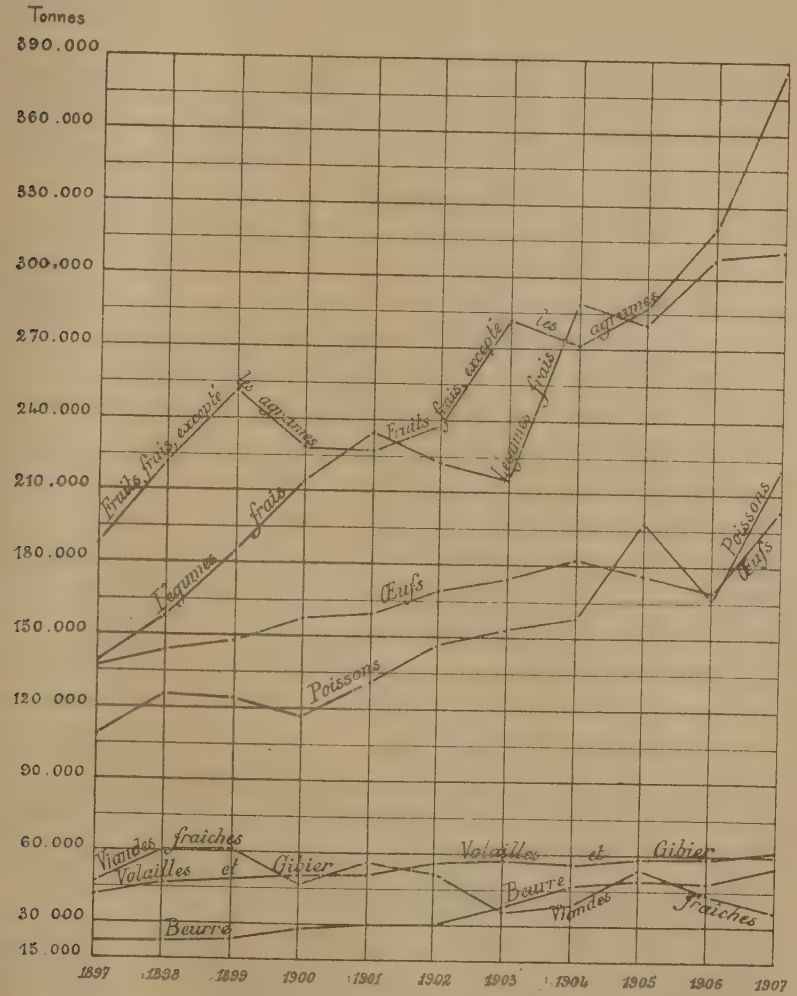

Fig. 3. — Total imports into the chief countries of continental Europe (Germany, Switzerland, Belgium, France), by class of produce.

Explanation of French terms : Fruits frais, excepté les agrumes = Fresh fruit, excluding oranges and lemons. — Légumes frais = Fresh vegetables — Œufs = Eggs. — Poissons = Fish. — Viandes fraîches = Fresh meat. — Volailles et gibier = Poultry and game. — Beurre = Butter.

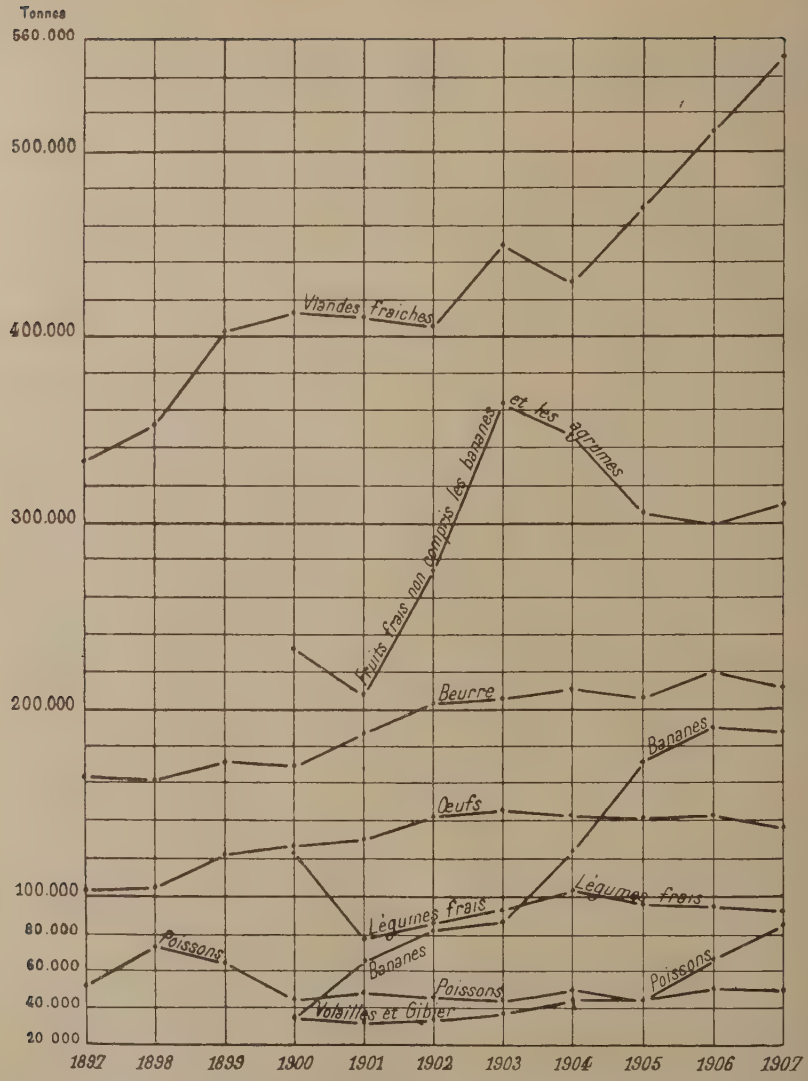

Fig. 4. — Imports into England. — For the periods before 1900, the English returns gave some articles in value or in volume and it has not been possible to compare these figures, with any degree of accuracy, with the figures given from 1900 onwards in hundredweight.

Explanation of French terms: Viandes fraiches = Fresh meat. — Beurre = Butter. — Œufs = Eggs. — Poissons = Fish. — Fruits frais, non compris les bananes et les agrumes = Fresh fruit, excluding lemons, bananas and oranges. — Légumes frais = Fresh vegetables. — Bananes = Bananas. — Volailles et gibier = Poultry and game.

But among all these traffics, it is fruit, vegetables, eggs and sea-fish which show a preponderating importance and great progress.

The extent and growth of the needs which are thus exhibited, account for the energy which the exporting countries bring to bear on the development and increased production of these articles, making of these special traffics really a national matter.

Thus this national interest explains why Italy stipulated for increased facilities for its fruit traffic, when the convention of 20 April 1909, for the repurchase of the St. Gothard Railway by Switzerland, was agreed to by Switzerland, Germany, and Italy.

A still more characteristic instance of this prepossession in favour of a public interest is shown in the very instructions issued by the Italian State Railway to its employees.

Thus in the preamble to secure order No. 111 of 25 November 1906 concerning the routes to be followed by wagons containing perishables, we find this phrase:

And as it is a question of an industry of an eminently national character and interest,

The subsequent orders 63 and 125 of 1907 contain on the same point :

On this occasion, we once more strongly recommend all the employees to observe the fixed rules... and to take the greatest possible care in effecting these transports, as they are of evident importance to the national economy.

Finally, the last service order No. 72 which summarizes and replaces all the previous ones, is of special interest, not only because it emphasizes this point of view of the national interest, but because it introduces the principle, of which we will see the development later on, that the existence and the progress of this traffic in agricultural produce depends essentially on the speed of conveyance :

The present regulations are chiefly devised to ensure the quick transport of articles of food in large quantities from their place of production to the consuming markets, principally the foreign ones; this is an essential condition for the existence and extension of the agricultural produce industry which is of national interest.

An equal activity, combined by the same feeling of the importance of these traffics to the national interest, is shown by Germany in the case of its fisheries, by Bulgaria in the case of its eggs, by Russia and in Denmark in the case of their eggs and butter, and by France in the case of all its produce.

The preceding curves have shown us the nature of the produce principally required on the European markets; we will now consider how these demands are distributed between the different countries and determine in which the demand is greatest.

This we will do by means of the curves given below; these will show the progress in the different importing countries, for each of the groups of produce considered.

The quite exceptional imports of England having already been shown in a previous figure, these new curves will be limited to the continental countries.

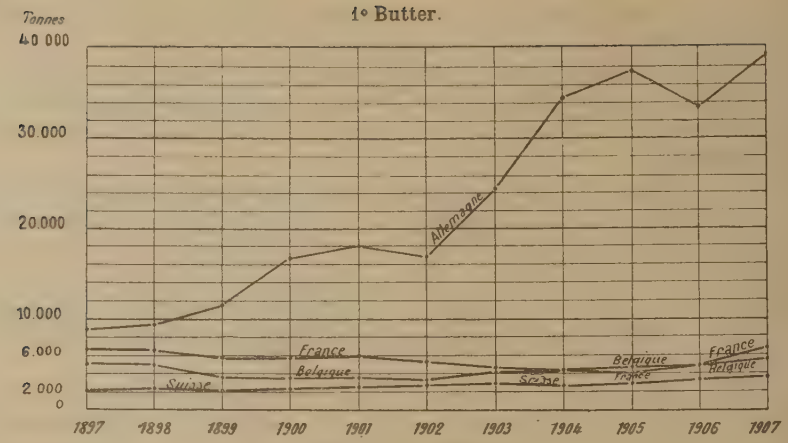

Fig. 5. — Butter.

Germany alone shows a particularly active and growing market. In France the quick increase in home production makes the import curve undulate.

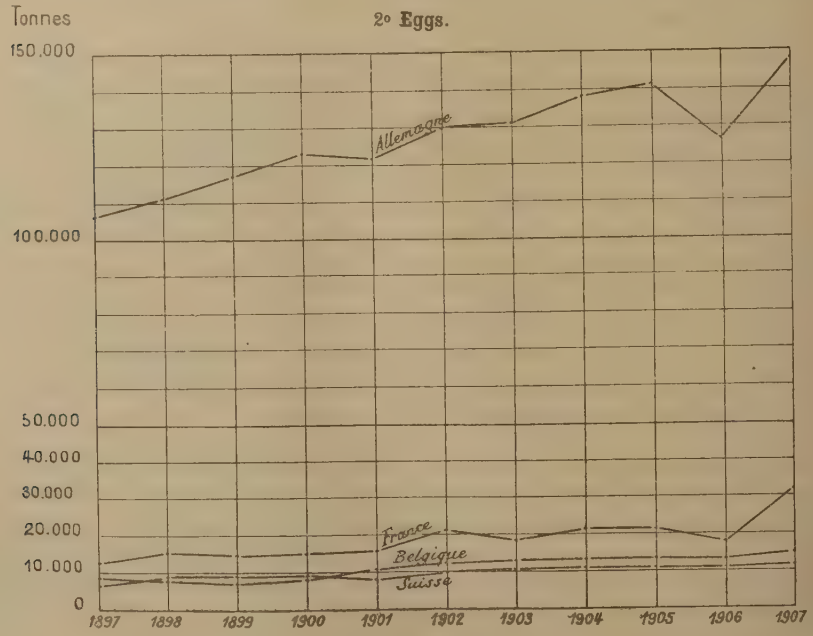

Fig. 6. — Eggs.

Explanation of French terms: Allemagne = Germany. — France = France. Belgique = Belgium. — Suisse = Switzerland.

Here again German imports are very important and are growing very appreciably, while Belgium and Switzerland only show slight variations. Taking the population into consideration, French imports are of comparatively minor importance, but yet show an appreciable increase.

3° **Fresh meat.**

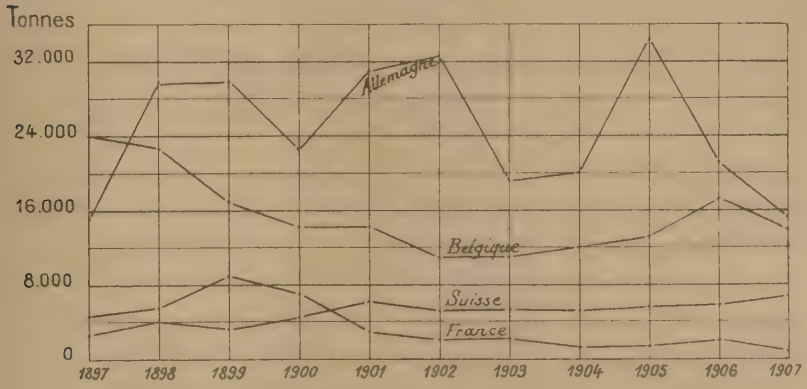

Fig. 7. — Fresh meat.

Explanation of French terms : Allemagne = Germany. — Belgique = Belgium. Suisse = Switzerland. — France = France.

As compared with the general progress in the case of the other perishables, the small increases, the decreases even in the fresh-meat imports, show the efficiency of the measures of protection taken by different governments against these imports; but it may be thought that they also depend on the special difficulties involved in carrying these very perishable articles when using the ordinary railway rolling stock.

The very considerable growth in these imports in the case of England is in fact not due only to fewer restrictive measures in that country, but above all to the development of refrigerating machinery on the ships carrying this traffic.

At every time of year, in spite of the long time required for the sea voyages, this very delicate article of food is at present safer on board ship, however long the journey, than on ordinary railway rolling stock, during the hot season, in spite of the shortness of the journeys.

4° **Poultry and game.**

Here again the German traffic is much the most important and is increasing very markedly. In that country the customs returns distinguish between small animals which are alive and those which are dead, and we have given two corresponding curves as it seems to us they lead to an interesting observation confirming the final remark of the last article.

These curves show indeed the remarkable disproportion between these two traffics and the much greater importance of the traffic in live animals. Now it is a priori evident, that in spite of quicker transport, in spite of the care taken in providing food and drink in their cages, these small animals, when packed into wagons which are as fully loaded as possible, must certainly suffer and lose some of their weight and their quality.

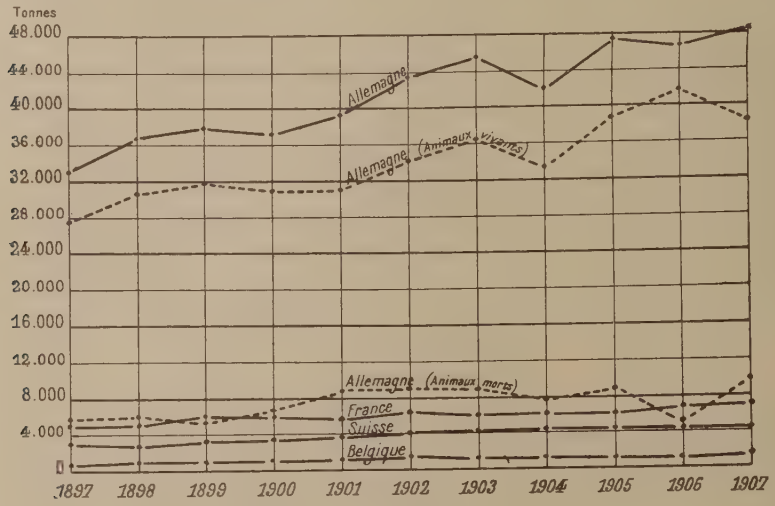

Fig. 8. — Poultry and game.

Explanation of French terms: Allemagne = Germany. — Allemagne (animaux vivants) = Germany (Live animals.) Allemagne (animaux morts) = Germany (dead animals). — France = France. — Suisse = Switzerland. — Belgique Belgium.

Why then is it that such carriage is preferred to that of dead animals, if it is not that in the case of these small and delicate animals, still more than in the case of fresh meat, the use of ordinary railway rolling stock does not give enough security?

The answer of the Bavarian State Railway moreover, refers summarily to these difficulties by stating that the traffic in dead poultry is stationary because *its transport is disadvantageous from many points of view.*

5° Fish and shell-fish.

Important though these imports may be, particularly in Germany, they only give a very incomplete idea of these special articles of consumption and of the important traffic which results. It is in fact evident that the supplies in each country are in the first place found by its own boats, so that the curves shown would require to be supplemented by the yield of the national fisheries; now this amounted in France to

130,400 tons in 1897 and to 195,900 tons in 1907, sardines and shell-fish not included; while in Germany it earnly doubled the total tonnage of fish carried on the railways, from 234,700 tons in 1897 to 451,600 tons in 1907.

Special attention is drawn to the importance of these imports into Belgium, taking into consideration the smaller population of this country.

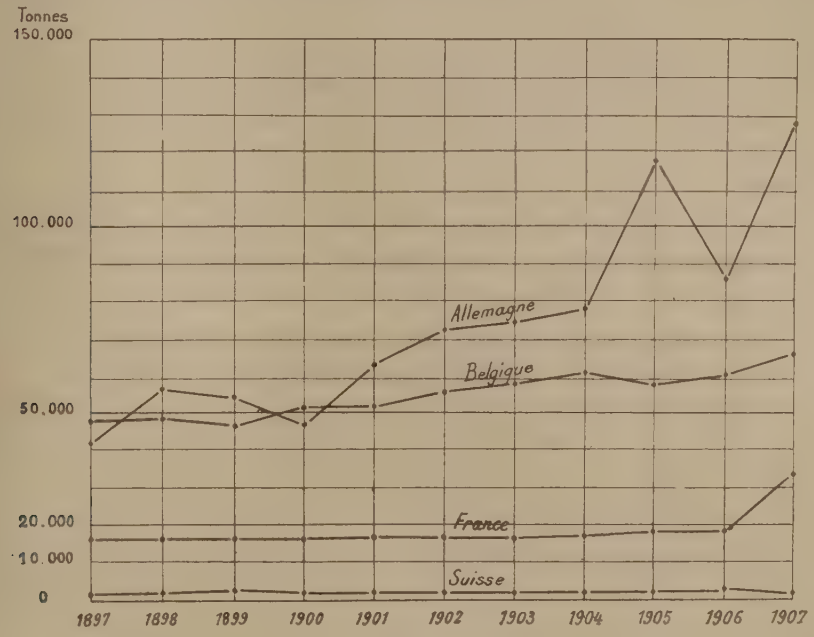

Fig. 9. — Fish and shell-fish.

Explanation of French terms : Allemagne = Germany. — Belgique = Belgium. France = France. — Suisse = Switzerland.

6° Fresh vegetables.

It is evident that in the cases of Switzerland and Belgium, the smaller populations of these countries have to be taken into consideration in this comparison, just as in the last case; it must however be recognized that this traffic is not affected by appreciable fluctuations there; on the other hand France, which exports more than it imports, generally has enough for its own proper consumption; this traffic thus is of special interest in Germany alone and it is evident what great progress there is there, for the tonnage of the imports increased from 97,200 tons in 1897 to 208,700 tons in 1907; thus it became more than doubled.

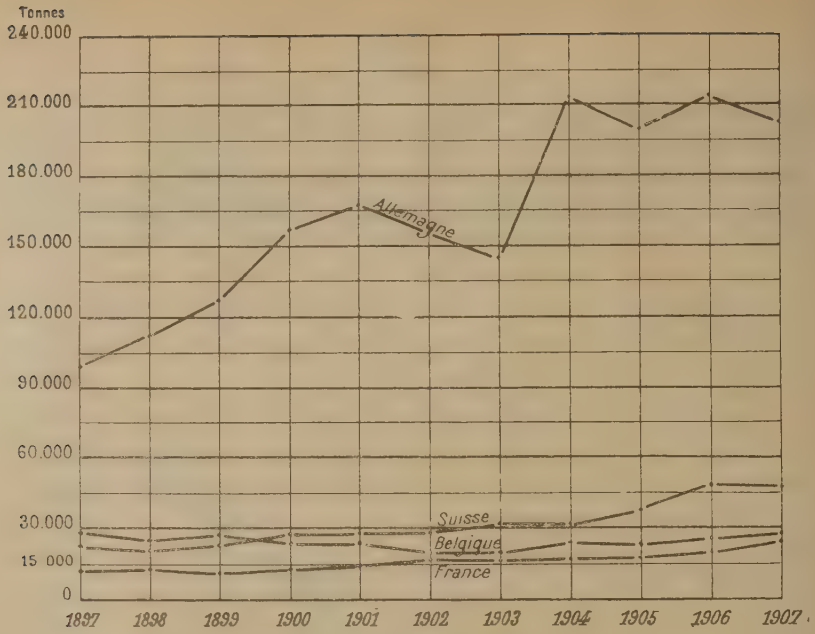

Fig. 10. — Fresh vegetables.

Explanation of French terms : Allemagne = Germany. — Suisse = Switzerland.
Belgique = Belgium. — France = France.

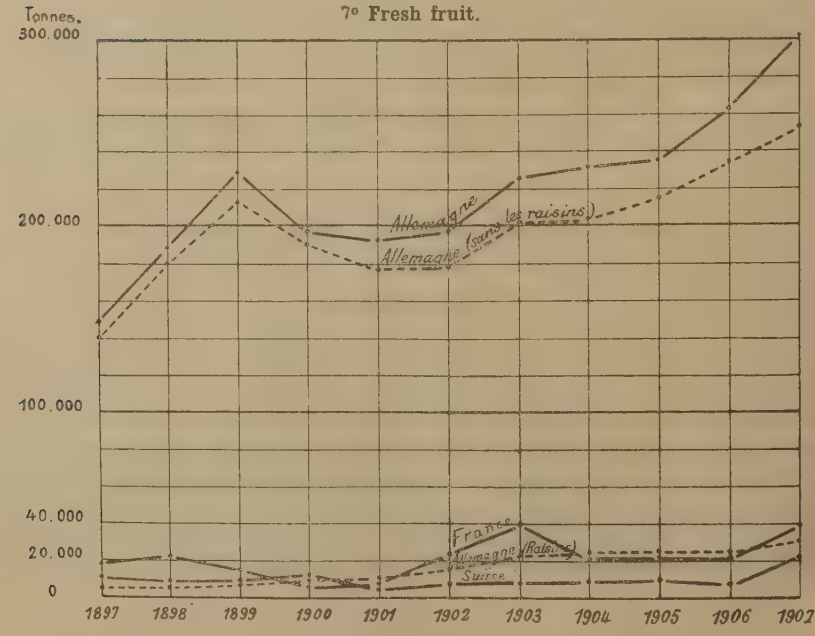

Fig. 11. — Fresh fruit.

Explanation of French terms : Allemagne = Germany. — Allemagne (sans les raisins) = Germany (grapes excluded)
France = France. — Allemagne (raisins) = Germany (grapes). — Suisse = Switzerland.

The consumption of this article in Germany, just as in the case of the preceding articles, is seen to increase, almost to double, as far as fruits other than grapes are concerned; for it increased from 141,600 tons in 1897 to 269,000 tons in 1907. As regards grapes for eating at table, a real article of luxury, the consumption was quintupled; it rose from 7,000 tons in 1897 to 35,400 tons in 1907.

This consumption increased still further in 1908, in spite of the slump which afflicted the industrial world. The following table shows the share and the progress of this grape business of the different countries producing them.

—	1905.	1906.	1907.	1908.
	Tons.	Tons.	Tons.	Tons.
Italy	11,600	12,400	17,300	22,700
France	5,100	7,800	10,400	10,400
Algiers	100	1,000	500	900
Spain	2,700	3,400	5,100	3,700
Austria-Hungary	1,100	1,000	900	1,200
Other countries	1,500	1,000	1,200	1,000
Total	22,100	26,600	35,400	39,900

The data given in appendix 2, together with the curves representing them, well define, we think, the condition of the European market as regards perishables. It shows clearly that besides England, Germany, on account of the progress of its population and of its wealth, has become an important market for such produce; this market is growing quickly and without interruption, and attracts large quantities of produce of a most diversified character, produce of farms, of kitchen gardens and of orchards.

Looking at it now from the other side of the question, it is interesting to see how these imports are divided among the different producing countries; and to what extent, and in what lines, each of them contributes to the supplying of these great markets of consumption.

The statistical tables in appendix 2 enable us to get a general view of this; but as in the case of imports, it appears preferable to condense the figures shown in these tables and to represent them in the form of curves which appeal more to the eye and make more evident the differences between the results as well as the conclusions to be drawn from them.

The examination of this diagram (fig. 12) suggests a number of general observations which seem worthy of attention.

In the first place one is struck by the great difference of the results obtained in Spain as compared with other countries. The climate and conditions are however much the same as say in Italy or the Danubian countries; yet exports are much smaller.

It is also to be noted that of the total 88,500 tons in 1907, 18,400 tons only, that

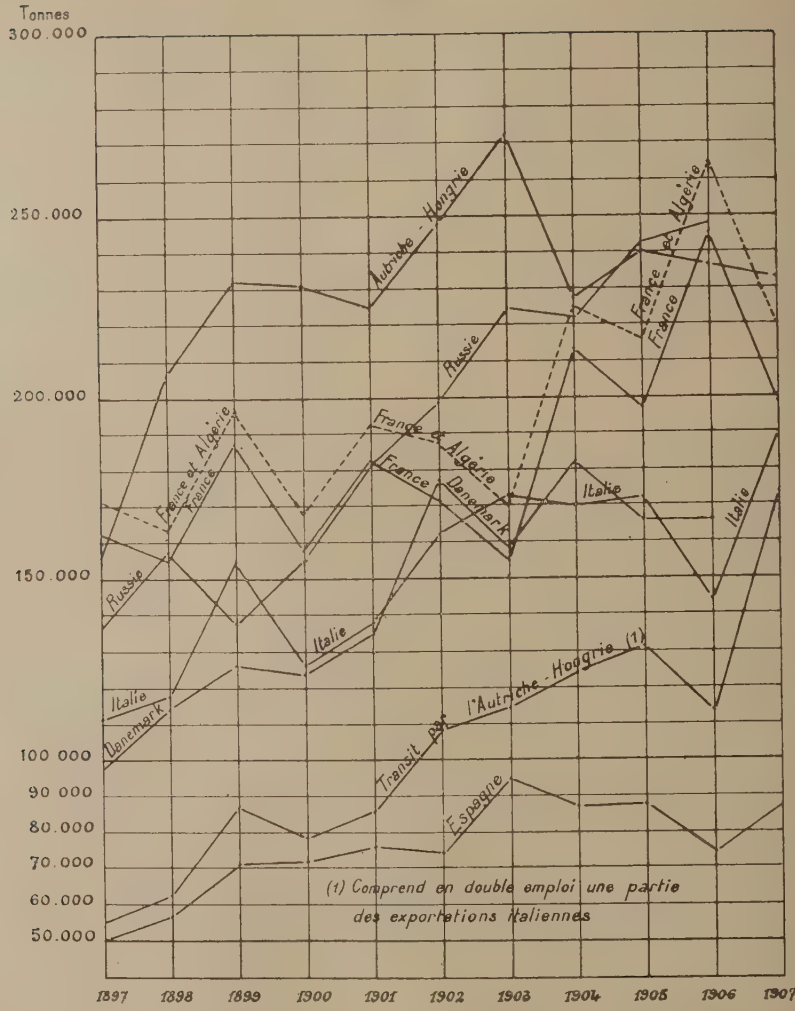

Fig. 12. — Total exports of the chief exporting countries of continental Europe.

Explanation of French terms: Autriche-Hongrie. = Austria-Hungary. — Russie = Russia. — France et Algérie = France and Algiers. — France = France. — Italie = Italy. — Danemark = Denmark. — Transit par l'Autriche-Hongrie (1) = Balkan countries and Turkey. — Espagne = Spain. — (1) Comprend en double emploi une partie des exportations italiennes = Part of the Italian exports are counted twice over.

is to say an insignificant amount, were exported across the frontier by the French railways, while the rest, which consisted chiefly of the special Almeria grapes, was forwarded by sea.

Such an inferiority is no doubt to be attributed to the fact that in Spain the government and the railways are occupied by other matters, and have not yet devoted any special attention and special measures to this interesting branch of production, without which it cannot become developed; while in other countries the contrary has been the practice.

Here this development also depends on the assistance of the French railways; but the European market is big enough to absorb everything and moreover, owing to the difference of the seasons, the Spanish harvest could not affect French production which it would on the contrary supplement; the French railways would thus have a real interest in giving the assistance which they have actually spontaneously offered.

However this may be, the comparison of these results give this proof, should any be necessary, of the importance to this special traffic of the marked attention usually devoted to it by the railways; without it, not only could it not prosper, but it could not even exist.

In order to show more clearly the results obtained by comparing the curves of the different countries, from another point of view, we give in the following table the average results of the two first and of the two last years of the period considered.

—	1897 1898.	1906 1907.	Difference.	
			+	%
Russia	159,900	258,100 (1)	98,200	61
Denmark	105,600	166,600 (1)	61,000	58
Austria-Hungary	182,500	232,200	49,700	27
Balkan countries	59,100	143,600	84,500	143
Italy	114,400	167,800	53,400	47
Spain	54,400	81.600	27,200	50
France	168,300	242,200	73,900	44
Total	844,200	1,292,500	447,900	53

1905/1906.

Now only Denmark and Russia and above all the Balkan States, the most recent participators in this special traffic, show increases which exceed the mean; this according to a judicious remark made by the administration of the Hungarian State Railway, is because the development of industry and of wealth, the growth of population, in old countries such as Austria and Hungary, and to some extent Italy, determine the increase in home consumption to the detriment of the exports; a similar change is observed in France, where as we will see, the export of butter and

*

eggs, for instance, is decreasing, while the imports, particularly of eggs, are on the contrary increasing.

If this point of view be correct, the distance of the producing countries thus increasing, the distance the consignments have to be carried naturally tends to increase also; because owing to the delicacy of these goods the railways have continually to take more care and to increase the speeds, so that these perishables may be brought in a good state of preservation to more and more distant markets.

Finally, if we examine the progress of exports from France and Italy to England and Germany, we arrive at a singularly instructive conclusion.

In the two latter countries, the values given by the customs for French fruit are generally higher than those for Italian (1), and although France almost monopolizes the English markets as regards European fresh fruit (except as regards grapes), yet its sales in Germany but a few years ago were nearly nil, and that country was supplied with fruit by Italy nearly exclusively.

Now of late French trade has on the contrary grown largely as the following table shows :

YEARS.	Grapes for the table, cherries and other stone fruit.				
	Total.	from France.		from Italy.	
1900	21,600	2,400	11 %	11,100	51 %
1901	24,200	1,900	8 %	15,200	63 %
1902	29,500	4,100	14 %	20,600	70 %
1903	29,500	1,600	5 %	20,800	71 %
1904	39,200	6,300	16 %	22,600	58 %
1905	34,900	9,000	26 %	16,500	47 %
1906	38,400	11,000	29 %	17,700	46 %
1907	53,400	16,800	31 %	24,800	46 %
Increase from 1900 to 1907.	31,800	14,400	...	13,700	...
	147 %	600 %		123 %	

Now why did Italian fruit which found no appreciable market in England on the contrary have such an extensive sale in Germany? And also why is French fruit making such a rapid progress in the latter country, after such a long abstention?

The quality can not be the only reason; nor can the question of distance; besides the western districts of Germany are nearer to the French centres of productions than to the Italian centres; England takes more fruit from Spain than from Italy although the transport takes longer and costs much more.

But here other considerations arise; the business in fruit and fresh vegetables is

(1) Values according to the estimates of the German customhouse in 1904, in marks per ton

ARTICLE.	*France.*	*Italy.*
Grapes for the table	480 Marks.	340 Marks.
— for wine making	233 —	175 —
Stone fruit (other than cherries)	635 —	400 —
Fresh vegetables	642 —	180 —

carried out by telegram between firms which must know each other and have a mutual confidence in each other; now while the German Italian relations facilitated by the opening of the St. Gothard had become more strained for political reasons, the contrary was the case as regards Franco-German relations; an approach which seems to have taken place in the last few years has at once been followed by an increase in this special traffic.

We may conclude from this comparison that in order to develop the trade in perishables to the fullest extent, it is necessary to try to facilitate as much as possible the relations of individuals, and to accelerate and cheapen their means of communication.

After these general considerations and as a counterpart of the analysis made above of the needs of the consuming countries, we will now investigate, in the case of the chief exporting countries, of the European Continent, how the general export traffic is divided between the different groups of goods; then extending the analysis and studying for each group the participation of the different exporting countries, we shall be able to show the situation of the different producing markets, and, for each of the groups, the existing tendencies in the different countries.

The results shown by these curves (fig. 13) agree in a general way with those of the import curves of the chief countries of the European continent and of England; the differences observed are naturally caused by limiting this study to a certain number of countries, or else it would have become too long; thus for instance as regards sea-fish, the important exports of Germany, Holland and Belgium, are omitted, and as regards fresh vegetables, the exports of Holland, which on the other hand figure in the total imports of the consulted countries.

But allowing for this, and also allowing for the uncertainties which result from the different systems of classification adopted by the customs authorities in the different countries, from the greater attention they naturally devote to imports than to exports, it may here again be recognized that the future of this traffic in perishables chiefly affects eggs, vegetables and fresh fruit.

Butter, which contributes a fairly large tonnage, is *above all, as we have seen, intended for England or for Germany;* the bend in the curve shown by this article is it is true in contradiction with the observed progress of these imports into Germany; but the anomaly is above all due to the increase in the supplies sent from the English colonies, Australia and New Zealand, which have partly replaced continental produce in England.

The tonnage of these imports from the colonies oversea increased from 15,700 English tons (of 1,015 kilograms each) in 1895 to 23,000 tons in 1905 and to 45,100 tons in 1907.

It would also be necessary to take into account the exports from Holland as far as this special trade is concerned.

Finally, we find the same uncertain and inactive movements in the fresh meat

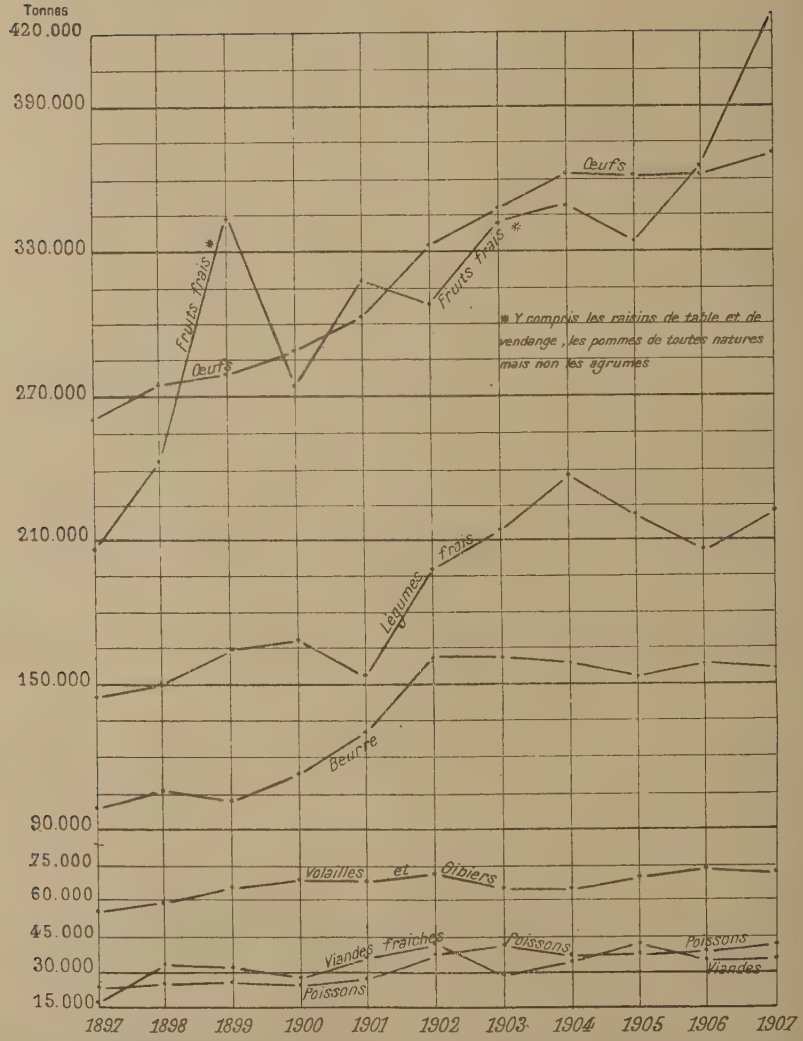

Fig. 13.* — Total exports of the chief countries of continental Europe (altogether). Russia, Denmark, Austria-Hungary, Balkan countries and Turkey, Italy, Spain, France (with Algiers). By class of produce.

Explanation of French terms : Œufs = Eggs. — Fruits frais* = Fresh fruit*. — * Y compris les raisins de table et de vendange, les pommes de toutes natures mais non les agrumes = * Including grapes for table and for wine-making, and apples of all kinds; but excluding oranges and lemons. — Légumes frais = Fresh vegetables. — Beurre = Butter. — Volailles et Gibier = Poultry and game. — Viandes fraîches = Fresh meat. — Poissons = Fish.

traffic, and in the poultry and game traffic, traffic which is hindered by the great delicacy of these goods, by the deficiencies of the rolling stock used to carry such goods, and as regards meat in particular by the customhouse or sanitary restrictions which some countries put in the way of these imports.

In the diagrams which follows we will examine the shares of each country in these different exports.

1° **Butter.**

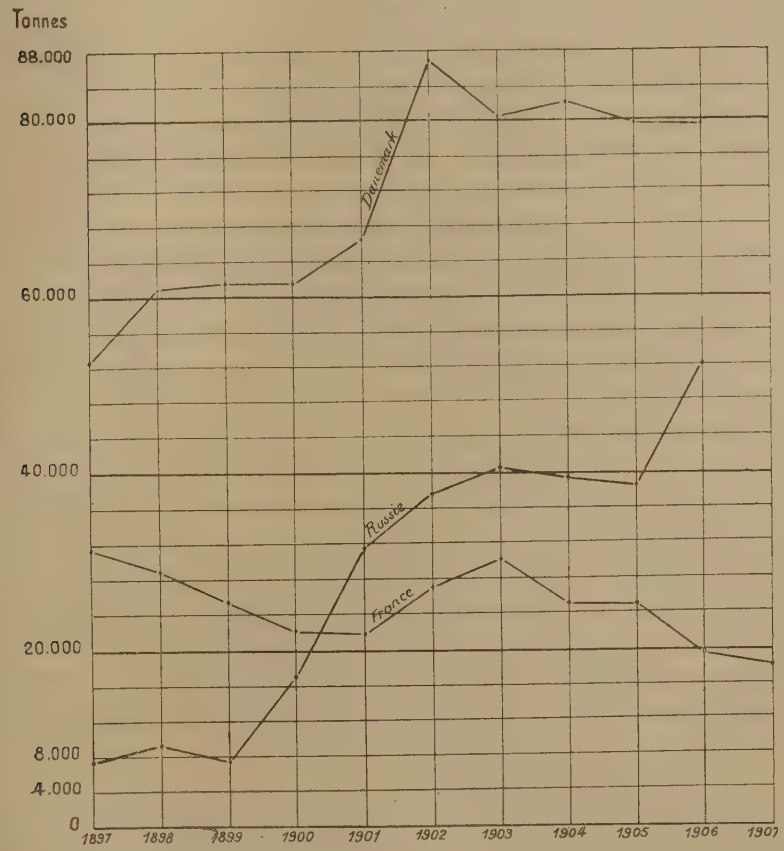

Fig. 14. — Butter.

Explanation of French terms: Danemark = Denmark. — Russie = Russia. — France = France.

We took the opportunity, in discussing the last diagram, to explain the general state of this butter traffic, and how the exports of European countries now had as

competitors, at least in the English market, produce sent from the distant countries of Oceania.

The Russian traffic, the remarkable progress of which was momentarily suspended, in 1904-1905, by the Russo-Japanese war, consists nearly wholly of Siberian butter. In chapter IV, we shall see that the remarkable progress in this traffic is due to the refrigerator vans which are used for the very long journeys, just as that of Australian butter is entirely due to the use of refrigerators on board ship.

On the other hand, the growth of the prosperity in European countries, such as France for instance, results in an increase in the home consumption which naturally limits the amount left available for export.

2° Eggs.

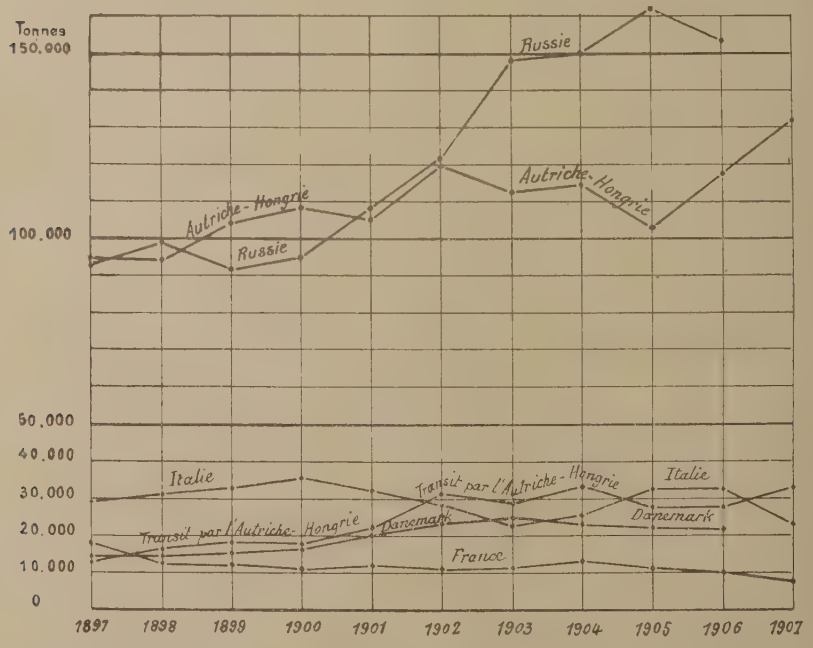

Fig. 15. — Eggs.

Explanation of French terms : Russie = Russia. — Autriche-Hongrie = Austria-Hungary. — Italie = Italy. Transit par l'Autriche-Hongrie = Transit viâ Austro-Hungary. — Danemark = Denmark. — France = France.

In the case of eggs as in that of butter, the traffic of the countries which were formerly exporting countries, such as Italy and France, varies under the double influence of the development of home consumption and the competition of more distant countries; above all Russia and, in particular, Siberia, have more and more

tendency to supply the European market and to their influence is no doubt due the slackening which has of late years been observed in the progress of the exports from Denmark and from the Danubian countries.

3° Fresh meat.

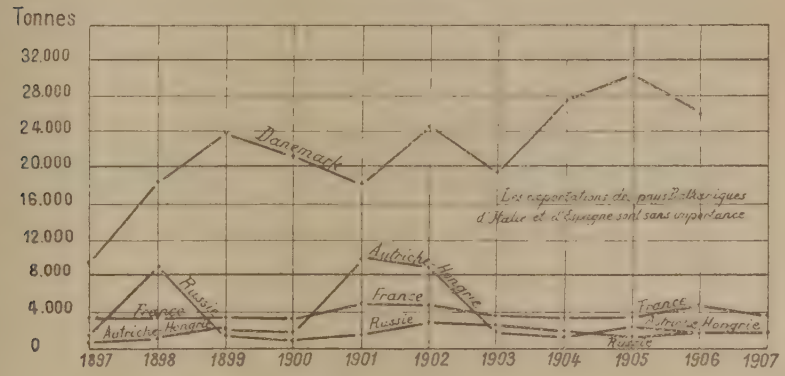

Fig. 16. — Fresh meat.

Explanation of French terms : Russie = Russia. — Autriche-Hongrie = Austria-Hungary. — Italie = Italy. — Transit par l'Autriche-Hongrie = Transit viâ Austro-Hungary. — Danemark = Denmark. — France = France. — Les exportations des pays Balkaniques, d'Italie et d'Espagne sont sans importance = The exports from the Balkan States, Italy and Spain are unimportant.

As we have already explained, this international traffic is hampered by the customs or sanitary restrictions of the different countries, and therefore cannot expand fully; moreover, it requires a special transports organization with an improved rolling stock, an organization which is generally not in existence at present.

The Danish exports however are an exception to this general rule. Their development is due above all to the increase of pig-keeping in that country; this development is in direct connection with the dairies because all the secondary products of the latter are used for feeding the pigs.

4° Poultry and game.

As appears only natural, the traffic in poultry and game follows to a certain extent the same path as that in eggs.

Russia however shows a much moremarked superiority than in the latter traffic; this may depend on a smaller home consumption.

If we examine the customs returns we make the same observation as when we studied the imports, that is to say the transport of living animals in much the more important item.

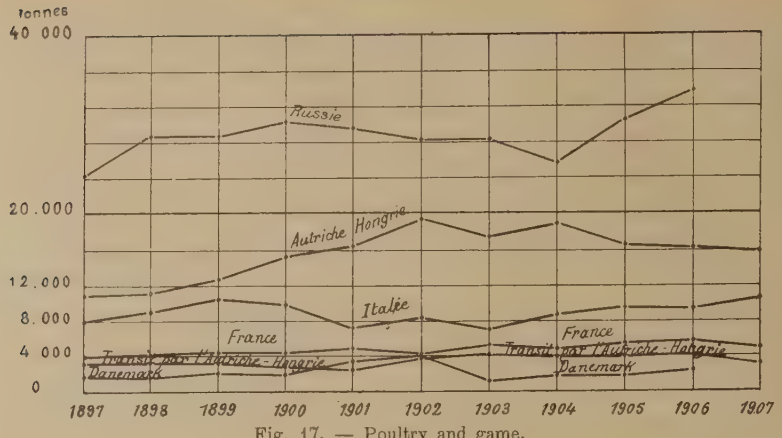

Fig. 17. — Poultry and game.

Explanation of French terms : Russie = Russia. — Autriche-Hongrie = Austria-Hungary. — Italie = Italy. France = France. — Transit par l'Autriche-Hongrie = Transit viâ Austro-Hungary. — Danemark = Denmark.

Thus the Russian export statistics for 1906, according to numbers of animals, shows :

Live poultry	2,961,871 head.
— geese	6,395,632 —
Dead poultry	499,769 —

We think this difference is to be explained, as before, by the special difficulty of conveying these comparatively-expensive and eminently-perishable articles by means of the ordinary rolling stock.

On the other hand it appears from information recently submitted to the International Refrigeration Congress (Paris, October 1908), that the preparation and the preservation of dead poultry are carried out in Russia under very defective conditions. The measures applied and the results obtained in the case of butter seem to indicate what road to follow.

5° Fish.

This diagram is limited to the countries which share most largely in the total perishables traffic and does not include certain countries the exports of which are, at least as far as fish is concerned, of special importance; namely Germany, Sweden and Norway.

Besides, the international traffic is, as we have already shown, quite out of proportion to the home traffic of each country supplied by its national fisheries, and it is the latter traffic which is more specially worthy of attention.

However that may be, this traffic shows an important increase in Denmark, and a very appreciable one in France, so well favoured by the extent of its coast; and for this reason it would seem that it should show a much greater activity.

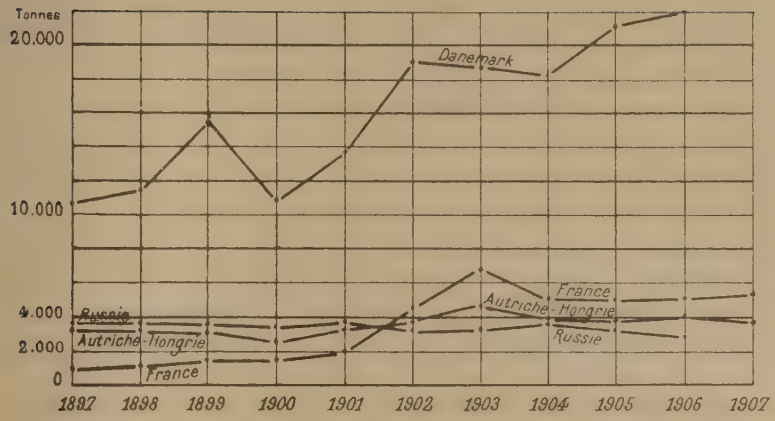

Fig. 18. — Fish.

Explanation of French terms : Danemark = Denmark. — Russie = Russia. Autriche-Hongrie = Austria-Hungary. — France = France.

6° Fresch vegetables.

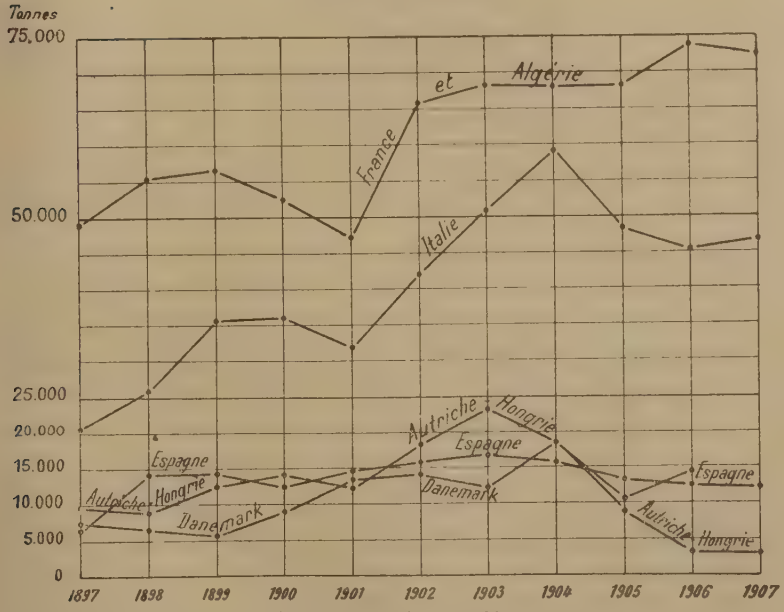

Fig. 19. — Fresh vegetables.

Explanation of French terms : France et Algérie = France and Algiers. — Italie = Italy. Espagne = Spain. — Autriche-Hongrie = Austria-Hungary. — Danemark = Denmark.

This curve (fig. 19) again shows the weak position of Spain as compared with Italy. The latter country really shares with France the European markets for high-class and early vegetables.

In order to obtain a complete idea of this traffic it would be necessary to add the very important exports from Holland where market-gardening is very highly developed and which supplies the industrial districts of West Germany to a large extent.

These Dutch imports of fresh vegetables into Germany have increased very rapidly of late years; they amounted to 15,200 tons in 1885, to 45,400 tons in 1895 and to 113,100 tons in 1905.

If on the other hand we compare the progress in France and Italy, taking the average of the first two and of the last two years of this period, we obtain the following table :

—	1897/1898.	1906/1907.	Difference.	
			+	%
Italy.	22,750	45,950	23,200	102
France	49,400	72,200	22,800	46

7° **Fresh fruit.**

The vicissitudes of this special traffic exhibited by the summits and hollows of these curves depend on the variations in the annual harvests both in the exporting and in the importing countries.

Thus we see in France for instance the effect of the two exceptionally-bad years 1902 and 1903.

But these variations themselves vary in the different districts, and it is curious to note on the diagram how frequently the summits of certain countries correspond to the hollows of others, in other words, how the surplus in the former counter balances the deficit in the latter.

It is for this reason no doubt that in the general diagram (fig. 20), which represents the resultants of these different movements, the curves representing the total traffic show much less irregularity, and show a nearly continuous movement in advance.

These irregularities in the annual yield of the different countries, the limited period of time during which such consigments are sent, the particularly-delicate nature of these goods whose value depends mainly on their transport, have as result that of all the perishables, it is perhaps the fruit traffic which gives the railways the most difficulties and which they have to take most cares over.

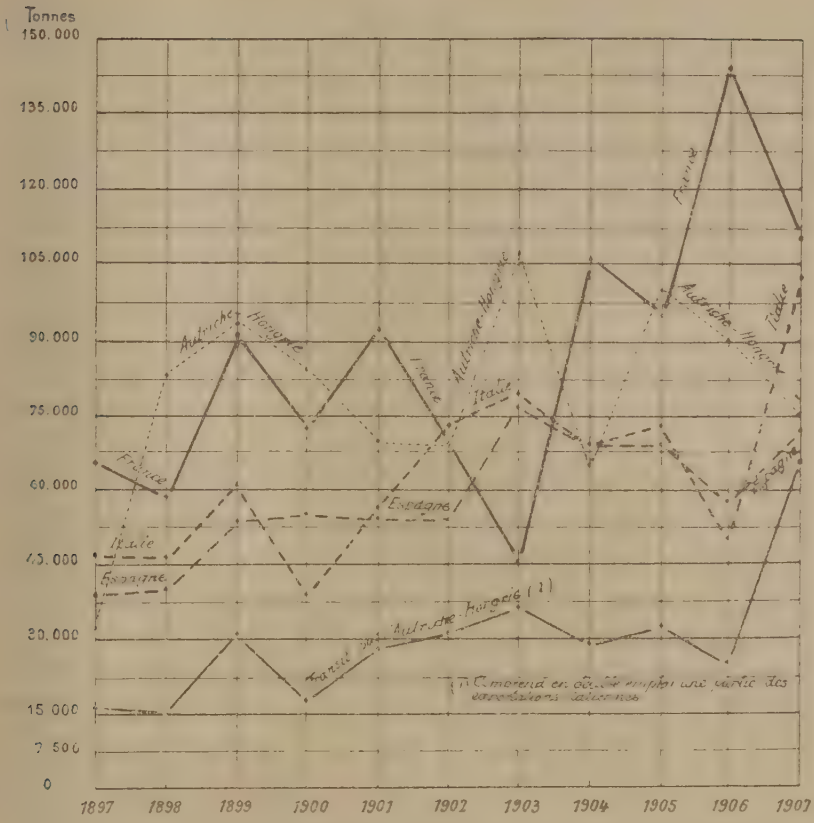

Fig. 20. — Fresh fruit, including grapes for the table and for wine-making, apples and strawberries; but excluding oranges and lemons.

Explanation of French terms : Autriche-Hongrie = Austria-Hungary. — France = France. — Italie = Italy. — Espagne = Spain. — Transit par l'Autriche-Hongrie = Transit viâ Austro-Hungary. — Comprend en double emploi une partie des importations italiennes = Part of the Italian exports are counted twice over.

SUMMARY.

Summing up this detailed analysis of the conveyance of perishables on railways we find that as a general rule these traffics are growing rapidly in consequence of the more general prosperity, of the increase in wealth and in population, of the greater and greater facilities given by the administrations, the details of which we will consider later on.

This progress is especially striking in the case of produce such as fruits and

vegetables, where the different countries in a way supplement each other, and the importation of which consequently does not meet with any serious opposition.

The same applies to farm produce, butter and eggs, the demand for which in industrial districts exceeds the amount which can be produced in those districts and makes it necessary to draw upon more and more distant countries.

In the case of sea-fish and of meat, on the contrary, attempts are everywhere made to protect the national produce; moreover in the case of meat more especially (and this is equally applicable to poultry), as it is no longer, as in the case of fruit, a question of produce which is worth very little where produced and which consequently one exposes without too hesitation to the risks of transport; for meat is an article of considerable value at the points of production already, and is very perishable; consequently the producer has but little desire to expose it to the risks of loss inherent to distant conveyance in rolling stock which is not perfectly suitable.

Hence more especially those important transports of live poultry which certainly cannot arrive at its destination without loss of quality and loss of weight, but which nevertheless arrives alive and still saleable; while with dead animals there is the risk of receiving spoilt goods unfit for consumption.

All this traffic in perishables, the importance of which has been shown in this paper, its progress and its development depends in short exclusively on the care taken in the conveyance.

The examination of the measures taken for the purpose by the different administrations as well as the improvments still to be desired will form the object of the subsequent chapters.

CHAPTER II.

Tariffs. — Rates and conditions of liability.

The heading of this chapter includes the two questions of the rates and of the liability of the railway, because they seem in fact interconnected to a certain extent on some of the railways, and because taken together they have to be considered from two entirely-different points of view.

Some administrations, considering the difficulties of the carriage of perishables and the extent of the risks run, try to escape those risks by offering the public reduced rates in exchange for limitations of liability.

Others (up till now only the French ones) take the opposite point of view; admitting that these perishables acquire nearly their whole value from the conveyance itself, they consider that a guarantee of proper arrival is by far the most important

consideration. Consequently they have decided to undertake this responsibility and to devote their efforts and their sacrifices to the acceleration of the conveyance, while on the other hand keeping their rates higher.

This essential difference between the points of view is certainly one of the causes of the differences observed between the tariffs of different countries, and it is evident how important it is to understand this difference when we are going to consider the question of the rates themselves.

Let us in the first place examine these two systems from the point of view of the trade and of produces.

As railways are naturally servants of the public, it is the opinion of the interested parties which has chiefly to be considered.

Now we find a sincere and recent expression of the wishes of the trade concerned in the minutes of an important commission which was appointed in France in 1905 to examine the question of the carriage of perishables. This commission included not only representatives of the railways, but also representatives of this special trade and of the producers, parlementarians and officials.

If we look through the minutes of the meetings, the reports and papers submitted by the parties concerned, we are struck by the small attention given to the rates themselves, and on the other hand by the great and significant attention given to the questions concerning the time to be allowed for the conveyance and above all to the responsibility of the railways to adhere to that time.

The nature and the extent of these considerations will be made very clear by the following extracts from these minutes :

Meeting of 11 November 1905 :

Mr. Omer Decugis, president of the " Chambre Syndicale des Commissionnaires en fruits et en primeurs" thinks :

" That we (in France) are advancing, and that if the railway companies will guarantee shorter times of conveyance to the consigners, which is *the great question*, we will easily find outlets."

At the same meeting, later on, Mr. Buisson, President of the *Syndicat des Mandataires à la vente en gros des fruits et primeurs*, made the following statement :

" The question of the time of conveyance is the paramount question : it matters but little to the producer to know under what conditions his goods are carried if these do not arrive in good time for their sale. In the case of early vegetables and fruit, twenty-four hours more are enough to make them unsaleable. At present when the producer consignor ascertains what the time of conveyance is, the information supplied by the despatching station is only an expression of probability and if the goods arrive damaged or too late the party interested has no claim against the company."

Mr. Buisson concluded by demanding that the carriage of perishables should cease to be

a matter of probability and *that the companies should be made liable in case of any delay. He proposed that this question of time should be placed at the head of the agenda.*

Meeting of 29 November 1905 :

Mr. Jouillat. President of the *Chambre Syndicale des Mandataires à la vente en gros de la volaille et du gibier aux Halles Centrales de Paris*, observed :

" The parties interested do not complain of the times occurring in practice when they are short. *They complain of the legal times, which are excessively long, behind which the companies shelter themselves when their service is irregular.*"

Similar wishes are expressed in other countries; they are more especially mentioned by the German administration.

Thus the *Prussian State Railway* states that the interested corporations and the public show a tendency to ask for more guarantees.

According to the *Baden State Railway*, the parties interested ask that even when the railway is not legally liable, it should grant compensation in a spirit of conciliation.

The *Saxon State Railway* states that the chambers of commerce ask that the liability of the railways should be increased.

The *Bavarian State Railway* mentions that the commercial world desires the abolition of the restrictions in the liability of railways specified in paragraph 77 of the home regulations.

Finally, although that country is not within the scope of this report, it seems interesting to note that the same tendencies at present are showing themselves in England. The railway companies there generally offer the public two scales of rates for these perishables, the lower being when the goods are carried at owner's risk only.

The difference between these two scales is moreover so great that the lower one is in fact nearly the only one applied.

Now these rates without liability, " owner's risk rates ", have been made the subject of strong complaint before the Commission appointed February 1908 by Parliament.

Finally, the meeting decided to ask for an extension of liability, drawing up a list of well-defined cases in which compensation is to be paid.

Generally speaking, the railways oppose these tendencies, and the fears on which the opposition is based are expressed in the answer to our list of questions, given by the administration of the Italian State Railway :

It is particularly necessary in the case of perishables that liability should be limited and that in tariffs providing for it, the presumption of irresponsibility of the railway should be maintained to compensate for the reduction of rate, taking into consideration not only the

nature of the goods, but also the fact that these may have been consigned in a bad condition, so as not to be able to stand the journey without damage.

As it is not possible to ascertain the state of the goods at consignment, and as it is nearly always not possible, without great difficulty, to ascertain with certainty at arrival, whether the goods when consigned were in good condition or otherwise, it is necessary to uphold, as far as possible, the principle of conveyance at the risk and peril of the consigners, and not to increase, in any case, the liability of the railway.

This way of looking at the matter has as result, that on most of the railways, the French railways excepted, it is very usual to apply to these consignments of perishables carried as quick freight, either simply the slow-freight rates, with their regulation times of conveyance, or the accelerated-slow-freight rates, with times still very long.

No doubt in practice attempts are made to carry the consignments quickly, and we shall see later on what remarkable efforts have been made for the purpose, and what results have been obtained; but in case of any irregularity, the power the railways have of appealing to the " legal time " practically eliminates all their liability.

In France, quite a different line was taken in the tariffs established in 1907 after the meeting of the commission referred to above : while the booking service and the actual carriage were accelerated as much as possible, it was decided to accept, as regards the public, and under certain conditions, liability for proper arrival, that is to say, for the arrival of the perishables at the time at which the trains in fact carrying them are due.

Which system is the better?

From the objective point of view, we have seen that the public incontestably prefers that the railways should be liable; from the subjective point of view of the latter, are not the fears shown everywhere with regard to these liabilities exaggerated, and is not immunity from them purchased at too dear a rate by the excessive reductions of the tariffs?

Statistics of the claims settled by the Paris Orleans station under the French system of liability, during the period 1 July 1908 to 30 June 1909, show that in the case of perishables carried as quick freight during a period of difficult service, the payments in consequence of delay and damage of perishables did not reach 55,000 francs (£2,200), for a traffic of 112,700 tons, for carrying which 7,300,000 francs (£292,000) were paid. This is less than 50 centimes per ton (4·87*d.* per English ton), or 0·75 per cent of the receipts.

This is relatively a very small proportion, and as on the other hand, the statistics and curves given above show, in the case of many French articles, that in spite of the higher rates, there has been at least as much progress as in other countries, must we not conclude from these different results, from the very attitude of the

parties interested, that these material reductions in the rates are not in reality properly counterbalanced by the elimination of the liability?

Reasons for reducing the rates or giving special facilities may however arise in some countries from considerations of another kind, from geographical, latent, as yet ill-defined considerations, but which nevertheless have a considerable influence on the making of the rates.

It is in fact very clear that this traffic of perishables, particularly of seasonable perishables, has a different character in two such countries as France, where there are such varied climates, from the mild winters on the Mediterranean coast to the bleak shores of the North Sea, and Germany, a country with a continental climate, much more uniform and colder.

In France, this diversity of climate and the earliness of the southern seasons have forcibly led to the exchange of produce, whatever so to say the rates might have been; in any case, one was in the presence of already-existing traffic, which in cases was considerable; more reserve was necessary in lowering the rates or else too great sacrifices would have been incurred.

In Germany on the other hand, on account of the relative uniformity of the produce of the whole land, there is no doubt less tendency to such a spontaneous exchange of produce between the different districts; on account of this minor importance of the existing traffic, there is less objection to the reduction of rates; such reduction moreover seems necessary in order to permit such exchanges between districts where the values of the produce differ but little; and it also seems necessary in the case of perishables necessarily purchased in other countries, which when they arrive at the frontier have already had to pay carriage thither, so as to facilitate their entry and their distribution inside the country.

This explanation which is so evident is not a simple work of imagination, for it is a remarkable fact that it is confirmed by the facts observed in the working of the different railway systems of one and the same country.

Thus for instance, in France, the Eastern and the Western Companies, whose systems extend throughout at about the same latitude, with little differences between the climates of the districts through which they run, have been able to make, for perishables generally, rates which neither the Paris-Lyons-Mediterranean nor the Orleans Companies, with their systems extending north and south with much greater diversity of climate, could look at.

Taking still another point of view, this diversity of produce exists in reality only during a rather short period of time, when on account of the earlier season of the south, its produce ranks as early fruit and early vegetables; it ceases when the production becomes more extended and then general; now for some time the Paris-Lyons-Mediterranean and the Orleans Companies have been showing a tendency to

lower their rates at the times, varying for the different kinds of produce, when they lose their early character, and this gives us an indirect proof, we may perhaps say an instinctive one, that it is this diversity in the seasonal periods which is really the true cause that the rates on the chief French railway systems are comparatively high.

Having explained the general notions which explicitly or latently influence the making of the rates for carrying perishables, we shall now consider in detail the tariffs applied in the different countries, or at least in the more important countries, in order to obtain a general grasp of the different principles on which the making of these tariffs is based.

In this investigation we shall follow the order adopted in the statistics, and consider separately, firstly the chief importing countries and then those who principally supply those imports.

GERMANY.

Germany comes first in this detailed investigation; owing to the very great importance of its traffic, its rating principles require a somewhat extended examination which is moreover facilitated by the very full information supplied by its different railway administrations.

Home tariffs. — As a general rule, the tariffs of the different State railways divide perishables *sent by quick freight* into two different classes :

1° Perishables which under a special tariff (" für bestimmte Eilgüter ") *pay slow-freight rates :* milk, butter, fish (except oysters and lobsters), some vegetables (gherkins, salads, broad beans, French beans, spinach), fruit (except so-called southern fruit);

2° *The remaining perishables pay quick-freight rates;* eggs, cheese, dead poultry, meat, oysters and lobsters, fresh flowers, vegetables not named in the special tariff, potatoes, colonial vegetables and fruit, game.

As far as one can conjecture, the division of the perishables into two classes seems logically inspired by a double consideration : firstly to charge quick-freight rates on such produce as poultry, meat, shell-fish, flowers, etc., which owing to its value can stand much higher rates; secondly by means of this higher rate to keep out of the quick-freight trains, which they would unnecessarily encumber, the less delicate perishables such as eggs, oranges, certain vegetables, etc., which can stand the time slow-freight trains take.

The scale of rates for the home traffic on the German railways is given in the following table.

The *quick-freight* rates are calculated at the general-class slow-freight rates on double the real weight.

*

DISTANCES.	Rate per 1,000 kilograms, in francs.								Extra charges (per 1,000 kilograms) in francs, for distances exceeding 40 kilometres.				
	Broken loads.		Truck loads of 5 tons.			Truck loads of 10 tons at slow-freight rate.			Broken loads.		Truck loads.		
				Slow-freight rate.			Certain vegetables listed.						
	Quick-freight rate.	Slow-freight rate.	Quick-freight rate.	General class A1.	Certain vegetables listed (1)(2) A2.	General class B.	(1) Special I.	(2) Special II.	Quick-freight rate.	Slow-freight rate.	Quick-freight rate.	Slow-freight rate, 5 tons (A1).	Slow-freight rate, 5 tons (A2) and 10 tons.
50	13 75	6·90	8·40	4·20	3·15	3·75	2·85	2 20					
100	26·25	13·15	16·80	8·40	6 25	7·50	5·65	4·40					
200	51·25	25·65	33·50	16·75	12·50	15·00	11·25	8 75					
300	73·75	36·90	50·30	25·15	18·75	22·50	16·90	13·15					
400	93·75	46·90	67·00	33 50	25·00	30·00	22·50	17·50	5·00	2·50	5·00	2·50	1 50
500	111·25	55·65	83·80	41·90	31·25	37 50	28 15	21·90					
600	126·25	63·15	100·50	50·25	37·50	45·00	33·75	26·25					
700	141·25	70 65	117·30	58·65	43·75	52·50	39·40	30·65					

(1) Broad beans, French beans, spinach, turnips, cauliflowers, red cabbage.
(2) Gherkins, salads of all kinds.

As regards accelerated quick freight, the general-class slow-freight rates are applied, on four times the real weight both for broken loads as well as for truck loads.

This scale of rates is applied by all the German railways; *the Bavarian State Railway* however extends the benefit of the *slow-freight* tariff to *all* vegetables as quick freight, for instance to asparagus, hops, horse-radish; so that on that system *quick-freight* rates are limited to eggs, cheese, poultry, meat, flowers, game and venison.

The general division of the perishables into two classes has moreover been affected by one important exception, by the temporary alterations of class of meat, the quick-freight consignments of which paid low-freight rates from 1 January 1907 to 31 December 1909.

The motive for this exceptional measure was the serious rise in the cost of meat in Germany. However, in spite of the considerable reduction (50 per cent) in the cost of carriage, there was no appreciable result, according to the majority of the railway administrations. This is a fact to be remembered when we examine, later on, the results which one may hope to attain by reducing the rates.

Apart from this exceptional and temporary provision, the tariffs of the different German State railways grant special reductions for the transport of milk which is usually only carried short distances; this we propose to examine more particularly, comparing the measures taken in this connection by the different administrations and the results obtained.

The German tariffs do not as a rule provide for seasonal conditions; such are not referred to except in the answer sent by the administrations of the Alsace-Lorraine State Railway; this railway carries every year, from 1 August to 15 September, nuts by quick-freight trains at slow-freight rates.

We also have to note a special tariff of *the Bavarian State Railway*, under the terms of which certain perishables, if sent in consignments *not exceeding 25 kilograms* (55 lb.), are sent as *express goods* (" Express Güter "), at broken-load *slow-freight* rates; these perishables are butter, lard, cheese, eggs, poultry, honey, fruit, berries, wild flowers, fresh meat, sucking pigs, lambs and kids.

A similar arrangement on *the Baden State Railway* is limited to the following articles : butter, cheese, eggs, live and dead poultry, honey, fresh vegetables of all kinds, fresh berries, fruit of all kinds except southern, grapes, plants of all kinds, wild flowers.

On the other hand the limit of weight of the consignments is increased from 25 to 50 kilograms (from 55 to 110 lb).

These are instances of agricultural-produce tariffs similar to those applied on English railways; they however possess the postal character, with rates fixed for zones and for given weights, like the Italian tariff and like that at present studied in France, the adoption of which now only depends on reduction of tax.

International tariffs. — Owing more especially to the central situation of Ger-

many and its increasing needs, the international tariffs there are much elaborated on the different railways.

Besides the combined rates with the Italian railways, which are the most important and which we will consider specially later on, we find in the answers of the different administrations mention of a certain number of combined rates of which the following is a summary :

Alsace-Lorraine, *South Germany and Switzerland* have common rates, the slow-freight rates of the different railway systems being combined, *but with guarantee of time explicitly limited to the slow-freight time*. *Alsace-Lorraine and Austria* have combined rates, the slow-freight German rates being combined with the reduced quick-freight rates of the Austro-Hungarian railways.

The *Wurtemberg State* has numerous international tariffs for the import of *eggs*, as slow freight with slow-freight rates; there is also a slow-freight combined tariff with Switzerland, for *cider apples*, but no particulars are given.

The *Baden State* has combined rates from Rotterdam and from Antwerp, in order to make the rates of those parts correspond with those of the German ports by means of equal mileage rates or fixed equal rates. There are also special rates from the Rhine ports to the Swiss frontier, fixed in such a way that combined with Rhine shipping rates they equal the through rates of the ports by other iron roads.

The *Bavarian State* has combined rates with several German railways :

For *eggs* in transit from the Levant, the Bavarian part of the rate being reduced to 4·9 pfennigs per ton-kilometre (0·962*d*. per English ton-mile);

For *live poultry* imported from Russia;

For *sea-fish sent from the North German ports* to the different stations in Bavaria;

For *sea-fish from Belgian and Dutch ports* at rates equal to those in the last case, as far as Gemünden, and supplementary rates beyond of 4 pfennigs per ton-kilometre (0·785*d*. per English ton-mile).

But these different rates do not seem to be based on only general principle, but to be of an occasional character or depending on circumstances.

This is not the case with the Italo-German combined tariff, with or without the use of Swiss and Austrian lines, and it is owing to this general character, to the importance and the variety of the traffic it affects, that it seems worthy of special examination.

The information supplied on the subject of this tariff by different administrations is very varied :

According to the *Prussian State Railway*, it is made by combining the rates of the different administrations and offers above all the advantage of through rates. This administration also mentions the existence of an exceptionally reduced tariff for complete truck-loads of all the perishables except *meat* and flowers (this exclusion of meat is to be noted; it quite corroborates what has already been said about the

impediments generally placed in the way of this traffic in international exchanges).

According to *Alsace-Lorraine* the German share in the quick-traffic transport consists of rates taken from the slow-freight tariffs of that country, but *with guarantee of time exclusively limited to the slow-freight time.*

The *Baden State* affirms that in the case of 10-ton truck-loads, the German railways calculate their share at the uniform rate of 6 pfennigs per ton-kilometre (1·178*d.* per English ton-mile), which moreover is the general-class rate B of the slow-freight tariff.

The *Bavarian State* applies to the fresh fruit of Italy, in transit via the Brenner, to other German countries, the reduced rates applying via the St. Gothard, and for the transport thus effected on its lines it charges the following rates per ton-kilometre :

5-ton truck-loads . . . 4·24 pfennigs (0·832*d.* per English ton-mile).
10-ton — — . . . 3·44 — (0·675*d.* — —).

In order to determine the reductions offered by the Italo-German tariff as compared with the ordinary German rates, it is best to compare these rates with the amounts charged for the German part, in the combined tariff, observing however that the latter tariff is in fact extended to nearly all perishables, while in the home tariff or in the combined tariffs with other countries, a certain number of these perishables do not benefit by the application of slow-freight rates.

TERMINALS.		Distance, in kilometres.	German share of Italo-German tariff, in francs.	Rates for class B (10-ton truck-loads), in francs.	Difference per 1,000 kilograms, in francs.
Munich, Central station	Pino. . .	568	44·20	43·50	+ 0·70
	Chiasso . .	613	47·50	46·90	+ 0·60
	Peri . . .	412	36·00	31·90	+ 4·10
Stuttgart, Central station	Pino. . .	508	38 40	39·10	— 0·70
	Chiasso .	552	41·40	42·30	— 0·90
	Peri. . .	648	52·10	49 50	+ 2·60
Dresden, Altstadt . .	Pino . .	1,023	74·60	77·40	— 2·80
	Chiasso . .	1,068	77·40	80·30	— 2 90
	Peri. . .	922	69·20	69·70	— 0 50
	Pontebba .	927	59·10	70·10	— 11·00
Berlin, Central Market .	Pino. . .	1,127	82·30	84 80	— 2 50
	Chiasso .	1,172	85·10	88·50	— 3·10
	Peri. . .	1,046	78·40	78·80	— 0·40
	Pontebba .	1,123	73·60	84·80	— 11·20

The preceding table in which several instances are given, illustrates the differences which are most frequently to the advantage of the Italo-German tariffs, but which are in some cases even to its disadvantage, no doubt owing to the influence of the rates of the intermediate Swiss or Austrian railway systems; but they are in every case of very little importance, certainly not important enough to exercise an appreciable influence on the development of this special traffic.

The advantages of the Pontebba line are to be noted; they result no doubt from concessions made by the Bavarian State Railway to compensate for the natural increase of the Italian rates for the distant point of transit and thus compete with the rates by the other routes.

SWITZERLAND.

a) Federal Railway.

Home tariff. — Perishables are carried under the conditions of special tariff No. 3 at an accelerated speed; this tariff fixes the following rates :

—	Rate, in francs, per 1,000 kilograms.		
	Broken loads, in francs.	Truck-loads.	
		5,000 kilograms, in francs.	10,000 kilograms, in francs.
Fixed charges	2 00	2·00	2·00
Rate per ton-kilometre up to 700 kilometres. . .	0·25	0 15	0·13

Under the conditions of this tariff the consignments accompanied by quick-freight way-bills are in fact treated like quick-freight consignments; but it is specially stipulated that in case of delay the slow-freight time can alone be claimed.

We may also mention a specially-interesting tariff for transport *under the same conditions as luggage*, with half an hour for delivery, for bread, fresh butter, new-laid eggs, liquid milk and fresh cream.

The rates applied are about 1 franc (9·75*d.* per English ton) less than the rates for broken loads in the tariff alone; but here again it is stipulated that in case of delay the slow-freight times alone can be claimed.

Milk is also carried under the conditions of an interesting subscription tariff which we will consider later on.

Sea-fish benefits by a tariff which seems exceptional; it is carried by ordinary passenger train at slow-freight rates (classes I, A and B), and by *express* train at single quick-freight rates, instead of double quick-freight rates.

International tariffs. — The answer of the Swiss Federal Railway mentions, in a general way and without giving details, the existence of tariffs common to it and to the railways of neighbouring countries.

b) St. Gotthard Railway.

These tariffs are also mentioned in the very summary answer of the St. Gothard Railway which states that there is a very complete system of common tariffs : Swiss-Italian, Belgian-Italian, German-Italian, based on the slow-freight rates; the scales of the rates are those of the Prussian State applied from terminal to terminal on the sum of the German and Swiss distances taken together.

BELGIUM.

Home tariff. — Perishables are carried at the rates of tariff No. 2, known as the accelerated-service tariff, the rates of which are calculated according to the following scale; in spite of its title and the fact that those perishables are carried on parcel trains or passenger trains, it only gives a legal right to the use of goods trains.

	Up to 5 kilometres	9·00 francs per ton.	
From	6 to 75 —	0·20 franc per ton and per kilometre more.	
—	76 to 150 —	0·16	— — — —
—	151 to 200 —	0·12	— — — —
—	201 to 400 —	0·08	— — — —

Plus 1 franc per ton for terminal charges.

International tariffs. — The answer of the Belgian State Railway does not explicitly refer to international tariffs; but we know that there are very important tariffs of this kind for transit traffic, through Antwerp and Ostend, of Italian produce, Austrian produce, etc.

HOLLAND.

a) Dutch State Railway.

Home tariff. — In principle the consigments are charged the quick-freight rates, which are double the slow-freight rates.

International tariff. — A through Franco-Dutch tariff is mentioned for sea-fish.

b) Dutch Railway Company.

Home tariff. — According to the administration of this railway, the very active

competition of river and canal navigation and particularly the progress made in motor boats, compels it to charge very low rates.

The rates applying to the different articles are given below; they are the slow-freight rates. The quick-freight rates are double the slow-freight rates, but actually, chiefly in consequence of the competition just mentioned, butter, eggs, milk, vegetables and fruit are carried as quick freight while only paying slow-freight rates.

DISTANCE	Broken loads (2).	Truck-loads.		
		Milk (1), eggs (1), butter (1), fresh cheese, poultry and small dead animals, fresh meat, sea-fish and other fish, fresh cut flowers, vegetables (1), fruit (1), game.	Vegetables and fruit in truck-loads.	
			5,000 kilograms.	10,000 kilograms.
	1·456 fr. (fixed charges).	1·04 fr. (fixed charges).	1·04 fr. (fixed charges).	1.04 fr. (fixed charges).
from 1 to 50 km.	0·0832 franc	0·0624 franc	0·0520 franc	0·0416 franc
— 51 — 150 —	0·0624 —	0·0520 —	0·0416 —	0·0208 —
— 151 — 250 —	0·0416 —	0·0416 —	0·0208 —	0·0208 —
über 250 —	0·0208 —	0·0208 —	0·0208 —	0·0208 —
	per kilometre more.	per kilometre more.	per kilometre more.	per kilometre more.

N. B. — The florin is converted into francs at the rate of 2·08 francs per florin.
(1) Carried as quick freight at slow-freight rates.
(2) Fresh meat not packed is not accepted except in consignments of 1,000 kilograms and charged at quick-freight rates increased by 150 per cent.

INTERNATIONAL TARIFF. — *With Germany* there are common tariffs for *butter*, *fish and shell-fish*, *some listed vegetables*, *milk*, *most of the fruits*, applying simply slow-freight rates to goods carried as quick freight.

In the case of *sea-fish*, a special quick-freight tariff applies the ordinary quick-freight rates to goods carried as *accelerated* quick freight.

With Belgium there are special slow-freight rates which apply to butter carried (no doubt as quick freight) from several Dutch stations to Liège and Antwerp.

JAVA DUTCH STATE RAILWAY.

This country and this railway do not take any appreciable share in the international movement of the perishable traffic.

Among the information supplied by this administration we may mention an original reduced tariff for conveying ducks in droves from one rice-plantation to another, after the harvesting; this tariff has given excellent results, the number having increased in one year from 40,000 or 50,000 to 130,000; this is an interest-

ing instance of the happy results which may be attained by adjusting the tariffs to the varying needs of local traffic.

EGYPTIAN STATE RAILWAY.

These articles are carried at the rates of a general quick-freight traffic. Exceptionally slow-freight rates are applied to fish carried on passenger trains; this once more shows the generally-recognized necessity of facilitating trade in that special article of food by reducing the rates for carriage.

NORWAY.

The greater number of perishables, when in *broken loads*, are carried as quick freight at the rates of the quick-freight truck-load tariff, or at the rates of the first series of the slow-freight tariff, uniformly increased by 40 ores.

The rates are charged moreover on a minimum weight equal to the number of packages consigned multiplied by 30 kilograms.

Here again we find the practice of a special liberal treatment for fish (except salmon) carried as quick freight; this pays slow-freight rates. When this fish is carried on fast trains, these rates are increased by 50 per cent.

We may note a regulation specifying a special increase of 25 per cent if the *night* train from Drontheim to Christiana is used.

RUSSIA.

Home tariffs. — The ample information supplied by the Vistula and especially by the South Eastern lines shows that the Russian railway tariffs seem simple as far as quick freight is concerned.

According to this information, both the slow-freight and quick-freight tariffs applied on the different railways conform to general regulations in force on all the Russian railways.

Notes added at the end of the tables of the different scales applicable to slow-freight traffic state, in a general manner, that *quick-freight* traffic is charged at the rates of the second class of the slow-freight tariffs; these rates are as follows :

1/12 kopeck per pood and per verst up to 400 versts or 0·127 franc per ton and per kilometre.												
1/15	—	—	—	—	more from	401 to	900	versts	or	0·102	franc	per ton and per kilometre more
1/18	—	—	—	—	—	901 to	1,800	—		0·085	—	
1/24	—	—	—	—	—	1,801 to	2,300	—		0·064	—	
1/36	—	—	—	—	—	2,301 to	4,688	—		0·042	—	
1/25	—	—	—	—	—	above	4,688	—		0·066	—	

As an exception, milk is carried as *quick-freight* at the rates of a scale No. 6 of the slow-freight rates. This scale is :

1/42 kopeck per pood and per verst up to 220 versts or 0·127 franc per ton and per kilometre											
1/53	—	—	—	—	more from	221 to 600	versts	or	0·046	franc	per ton and per kilometre more.
1/47	—	—	—	—	—	601 to 1,527	—		0·032	—	
1/56	—	—	—	—	—	1,528 to 1,600	—		0·042	—	
1/40	—	—	—	—	—	1,601 to 2,000	—		0·038	—	
1/42	—	—	—	—	—	2,001 to 3,190	—		0·036	—	
1/68	—	—	—	—	—	3,191 to 4,723	—		0·022	—	
1/42	—	—	—	—	—	above 4,723	—		0·036	—	

As another exception, fruit and vegetables are carried as quick-freight at the still lower rates of scale No. 7 which for fruit in particular is the same as that of the *slow-freight* tariff. This scale No. 7 is :

3rd class slow-freight	1/45 kopeck per pood and per verst up to 200 versts or 0·102 franc per ton and per kilometre.										
	1/48	—	—	—	—	more from	201 to 400	versts	or	0·085	franc
	1/49	—	—	—	—	—	401 to 630	—		0 08	—
Then	1/28	—	—	—	—	—	631 to 1,260	—		0·057	—
	1/70	—	—	—	—	—	1,261 to 2,843	—		0·022	—
5th class slow-freight	1/42	—	—	—	—	—	2,844 to 3,190	—		0·036	—
	1/68	—	—	—	—	—	3,191 to 4,723	—		0·022	—
	1/42	—	—	—	—	—	obove 4,723	—		0·036	—

per ton and per kilometre more.

The conversion of these rates into francs per ton and per kilometre has been effected by taking :

1 pood = 16·38 kilograms or 61 poods = 1,000 kilograms (2,205 lb.);
1 verst = 1·067 kilometres (0·663 mile);
1 rouble (gold) = 2.67 francs (2*s.* 1·63*d.*);
1 kopeck = 0·01 rouble = 2·67 centimes (0·256*d.*).

Although the notes added at the end of the tables only mention the application of these second-class rates to quick-freight broken loads only, it seems to include the larger number of perishables by truck-loads, as in the case of sea-fish the tables on the contrary explicitly mention the more favourable conditions granted in this case if by truck-load. In these cases, special scale No. 5 is applied, which is as follows :

Up to 615 versts, the above second-class broken-load rate. Beyond this :

1/35 kopeck per pood and per verst from 616 to 1,060 versts or 0·044 fr. per ton and per kilom.											
1/60	—	—	—	—	more from	1,061 to 1,200	versts	or	0·025	franc	per ton and per kilometre more.
1/80	—	—	—	—	—	1,201 to 2,984	—		0·019	—	
1/42	—	—	—	—	—	2,985 to 3,190	—		0.036	—	
1/68	—	—	—	—	—	3,191 to 4,723	—		0·022	—	
1/42	—	—	—	—	—	above 4,723	—		0·036	—	

5th class slow-freight

These scales of the Russian railways give rise to the following remarks :

The first is that the limits of the distances for given rates do not advance regularly, say by hundreds of versts, as on most European railways; these very irregular advances are made no doubt at points most advantageous for reaching important destinations or perhaps for managing existing traffic.

We may also mention the considerable diminution, at greater distances, in the scale of rates applying to fruit and vegetables and to sea-fish in truck-loads.

Finally, we note that the Russian engineers do not tie themselves down to the generally-observed rule of decreasing unit rates with increasing distances; for the unit rates are often raised, either to correspond with the existing scale of another class of tariff, or at the end in order to finish the tariff by a unit rate corresponding to the kilometer rate which the scale gives for the distance at which that last unit rate starts.

In addition to these rates, which are stated by the administrations of the Vistula and the South Eastern lines to apply to all the Russian lines, the latter administration mentions a special tariff applying to the carriage of daily produce on passenger and mixed trains in lots of 10 Russian pounds (9·02 English pounds) and which give, for instance, rates beginning at $^1/_{30}$ kopeck per consignment and per verst (0·0137*d*. per mile) for butter, and at $^1/_{80}$ kopeck (0·0052*d*. per mile) for milk.

Of the other administrations who have answered our list of questions, that of the *Moscow-Koursk* line states that it carries as quick freight, at slow-freight rates, the following perishables : eggs, butter, cheese, dead and live poultry and small animals.

The same system is applied to all other produce *when it is going to be exported*.

The *Transcaucasian* applies scales with unit rates the same as those given for the two first lines, the Vistula and the South Eastern, but decreasing with every zone of 25 versts (16·5 miles).

International tariffs. — The information supplied by the Russian lines mention the existence of international tariffs but without giving particulars. It is only mentioned by the Moscow-Koursk lines, as stated above, that the slow-freight tariffs are applied to quick-freight consignments going abroad.

We find however in the report of the St. Petersburg exchange committee of the first International Refrigeration Congress held October 1908 at Paris, the statement that the export of dead poultry to Western Europe would in the first place be hindered by the absence of any refrigerator-van service (this we will refer to later on), but also by the fact that in Russia the benefit of the reduced international tariffs would, on each line, be limited to three of four stations only; it would no doubt be useful to draw the attention of Russian railways to this point.

SIBERIA.

As Siberia is continually taking a greater and a greater share in the international commerce in perishables, particularly in butter, it would be very interesting to examine the rates in force on the Siberian railway system for this export traffic.

The answers made to the list of questions mention the existence of international tariffs for this traffics, more especially of common tariffs, with the internationa maritime union of the north; but they refer for details to Nos. 1940 and 1914 of the Official tariff bulletin, which were not supplied and which are not in our possession.

It is however possible to supplement this gap from the information supplied by the Russian committee to the International Refrigeration Congress.

It may be concluded that generally speaking the rates on the Siberian system are the same as those given above for the Vistula and South Eastern lines, and that the *slow-freight* tariffs are applied to the *quick-freight* export consignments.

In this way exported butter would have to pay to the ports and to the frontier the rates of scale No. 6 given above, and eggs by truck-load the rates of scale No. 14, which is as follows :

5th class	1/24	kopeck per pood and per verst up to 200 versts or 0·064 franc per ton and per kilometre.										
	1/28	—	—	—	—	more from	201 to	400	versts or	0·057	franc	per ton and per kilometre more.
	1/30	—	—	—	—	—	401 to	900	—	0·051	—	
	1/36	—	—	—	—	—	901 to	1,507	—	0·042	—	
	1/75	—	—	—	—	—	1,508 to	2,944	—	0·020	—	
6th class	1/50	—	—	—	—	—	2,945 to	4,175	—	0·031	—	
	1/45	—	—	—	—	—	above	4,175	—	0·034	—	

In the same note submitted by the Russian committee to the International Refrigeration Congress we find the following instances of export rates for butter, which show that the rates in the scale given above are still subject to further reduction, in accordance with a northern export tariff for beyond the seas.

From Omsk to the following ports.	Distance in kilometres.	Rate per 1,000 kilograms, in francs.		
		Special tariff No. 6 (1).	Northern export tariff for beyond the seas.	Proposed.
St. Petersburg.	3,524	112	106	122
Reval	3,829	115	108	126
Riga.	3,792	118	108	128
Windau.	3,960	119	111	130
Libau	3,983	119	111	131

(1) The rates given in this table are actually copied from the note of the Russian Committee, but it

These are very reduced rates; but the same source of information states that the administration of the railway is proposing to raise them to the figure given in the last column of the preceding table.

During summer, a very small extra rate of 1 kopeck per pood, or of 61 kopecks, or 1*s.* 3·90*d.* par English ton is charged for the use of the refrigerator vans necessary.

The note does not mention the rate for eggs; with reservation of the possible extension to this commodity of the special northern export tariff, we find that by the pure and simple application of slow-freight scale No. 14 to a distance of 3,750 versts, say about 2,486 miles, we obtain a rate of 84·28 kopecks per pood, or of 51·41 roubles per ton (£5.11*s.* 6·84*d.* per English ton).

AUSTRIA-HUNGARY.

The Austrian Railways have only given very summary information about their tariffs; the only special feature shown is that the Austrian State Railway reduces its slow-freight and quick-freight rates by 10 or 15 per cent in the case of 5 and 10-ton truck-loads for export.

As in Germany, the dearness of meat has led to the establishment of a provisional reduced tariff; this tariff which came into force 1 January 1907 did not give any appreciable result, just as in Germany; it was therefore very quickly withdrawn, at the end of March 1907.

The *Hungarian State Railway* applies, by means of a much-used formula, its slow-freight rates to quick-freight exports of butter, fresh berries, French beans, green peas, salads, fresh fruit, spinach, gherkins, fish.

It applies the reduced quick-freight rates to the other perishables exported : poultry, game, fresh meat.

We now see appear, for the first time in this analysis of the tariffs applied in the different countries, a subscription tariff granting subject to certain conditions reductions of 8 per cent in the quick-freight rates, of 20 per cent in the slow-freight rates, to customers who send at least 500 tons of the former traffic, 20,000 tons of the latter traffic, per year.

The administration of the Hungarian State Railway chiefly attributes the growth of this export traffic to this tariff which certainly seems calculated to stimulate the zeal of export merchants.

Another original tariff of this railway system reduçes by 10 per cent, all quick-freight and slow-freight rates for consigments to the central markets of Budapest

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is to be noted that if we take a rouble gold to be equal to 2·67 francs (2*s.* 1·63*d.*), the application of scale No. 6, for instance, to the 2,460 miles (3,711 versts) of distance from Omsk to Windau would give a rate of 97·57 kopecks per pood, or of 59·52 roubles per ton (68 pood), corresponding to 158·90 francs per ton (£6.9*s.* 1·92*d.* per English ton) instead of the 119 francs (£4.16*s.* 8·73*d.* per English ton) given in the table.

which are to be unloaded and sold by the official intermediate agents. It is however mentioned, that although the traffic has grown, it has not been observed that the prices of articles of food have been favourably affected, as was likely expected when this arrangement was made.

SPAIN.

Two companies have sent answers to our list of questions: the *Andalusian Railway* and the *Spanish Northern Railway*.

The *Andalusian Railway*, in the case of home freight traffic, applies to vegetables and fruit kilometer rates varying from 0·2213 to 0·2 peseta per ton (from 3·4738 to 3·1394*d.* per English ton-mile) (1); sea-fish is here again specially favoured, the lower limit of the rate being reduced to 0·1685 peseta (2·6450*d.*)

In the case of international traffic, fruit and vegetables which are exported pay quick-freight kilometre rates varying from 0·2518 to 0·2073 peseta per ton (3·9526 to 3·2541*d.* per English ton-mile). In the case of fruit imported from the Canaries, there is a common tariff, in combination with the Spanish Transatlantic Company and the Madrid-Saragossa-Alicante Railway; this reduces the limits to 0·1379 and 0·1269 peseta (2·1647*d.* and 1·9920*d.* per English ton-mile).

The *Spanish Northern Railway*, in the case of home quick-freight traffic, applies to perishables a special tariff with kilometre rates varying from 0·42 peseta (6·5929*d.* per English ton-mile) at 50 kilometres (31 miles) to 0·209 peseta (3·2807*d.* per English ton-mile) at 1,338 kilometres (831 miles).

The fixed rates applying to certain definite runs are based on kilometre rates which are within the following limits:

Live poultry	0·27 to 0·28 peseta	(4·2383*d.* to 4·3953*d.* per English ton-mile).
Dead —	0·28 peseta	(4·3953*d.* per English ton-mile).
Oysters	0·12 to 0·18 peseta	(1 8837*d.* to 2·8255*d.* per English ton-mile).
Fish	0·38 to 0·40 —	(5·9650*d.* to 6·2789*d.* — —).
Vegetables and fruit	0·22 to 0·23 —	(3·4534*d.* to 3·6104*d.* — —).

As regards international traffic, there are the following rates for sea-fish from Portugal:

To Madrid	0·41 peseta	(6·4359*d.* per English ton-mile).
To Saragossa	0·23 —	(3·6104*d.* — —).

For exports of fruit and vegetables to France, and for imports of produce from the Canaries, the conditions are very much the same as those mentioned in the case of the Andalusian Railway.

Finally the Spanish Northern joins in a common French-Spanish-Portuguese tariff; the kilometre rate on the Spanish section varies between 0·236 and

(1) Nominally the peseta has the same value as the franc; according to the present rate of exchange: 1 peseta = 0·91 franc, approximately.

0·225 peseta (between 3·7046*d.* and 3·5319*d.* per English ton-mile), and it moreover gives absolutely no result as far as the perishables traffic is concerned.

ITALY.

Italy is one of the countries where most attention has been devoted to the perishables traffic; we have already seen that it is even considered to have a character of national interest. The tariffs there are very complete and the answer sent by the administration of the Italian State Railway in answer to our list of questions and the documents sent with it, give very full information on the subject.

Home traffic. — The essential tool of this traffic in the *accelerated slow freight* tariff No. 50 which applies uniformly to all perishables in *truck-loads*.

The essential principles of this tariff, also the principle of the special export accelerated slow-freight tariff No. 55, is that it gives kilometre rates for 8-ton truck-loads (10-ton in tariff No. 55), subject to the condition that in the case of certain named goods, for instance oranges and lemons, fresh fruit and vegetables, the truck-load rates are applied to the whole load up to 8 tons; while in other cases, for instances butter, meat, fish, poultry, the truck-load rates are only applied to loads up to 4 tons; any weights over and above 4 tons are charged supplementary rates per ton, specified in the tariffs.

Further on, we shall give the rates of this tariff together with those of the similar tariff applied to exports.

In this tariff, we again find an instance (the first was in the *Hungarian State* tariff) of a subscription clause under which special rebates increasing from 0·5 to 5 per cent are given to customers who send from 100 to 1,000 truck-loads per year.

According to the information supplied by the administration of the Italian State Railway, this clause benefited in 1908 twelve customers as follows :

6	to the extent of	0 5	per cent.	1	to the extent of	2·5	per cent.
2	—	— 1 5	—	1	—	— 3	—
1	—	—. 2	—	1.	—	— 5	—

This is a rather small utilization of a clause which is however very logical from the business point of view.

The analysis of the special conditions of this tariff shows the following features :

1° The consignments are sent carriage paid ;

2° The acceleration of the traffic is determined by paragraph 6 of the tariff which runs as follows :

The time allowed for the delivery of the goods at destination is calculated at the rate of twenty four hours for each 225 kilometres (140 miles) of distance plus eighteen hours service operations and six hours for each passage from one railway system to another... The time allowed begins at the time the first train starts (through trains and those not carrying quick-freight goods excepted) after the full truck has been booked, providing that this booking has been effected at least an hour before that train starts.

3° The consignments by this tariff are carried at the risk of the consignor who can claim no compensation from the administration for deterioration, danger, natural waste of the goods, unless it is proved that this arises from the negligence of the administration.

The accelerated slow-freight tariff No. 901, which forms a sort of appendix to this slow-freight tariff No. 50, drawn up in a similar way, includes special reductions for consignments sent from the *southern* provinces to all the stations of the Italian State Railway system.

Besides these tariffs which apply exclusively to consignments consisting of truck-loads, there is for broken loads quick-freight tariff No. 3 which contains two scales of rates, one for consignments of 20 to 500 kilograms (44 to 1,100 lb.), the other for consignments over 500 kilograms (1,100 lb.). A table below give these rates.

This tariff contains one special clause analogous to one we will find in the export slow-freight tariff No. 55, according to which consignements of less than 500 kilograms (1,100 lb.) of certain named articles, sent in packages not exceeding 50 kilograms (110 lb.) in weight, can by agreement with the railway be carried the whole or part of the way by *through or accelerated* trains subject to the condition that 50 per cent more is paid for the use of *through* trains, and 25 per cent more for that of *accelerated* trains. The other goods named can under the same condition benefit by the use of *accelerated* trains only.

Finally this whole system of tariffs is supplemented by a tariff for small packages of agricultural produce, which contains the following rates, to be paid at the start :

DISTANCE.	Cost per package.			
	Up to 3 kilograms	From 5 to 10 kilograms	From 10 to 15 kilograms.	From 15 to 20 kilograms.
Up to 200 kilometres	0·45 fr.	0·55 fr.	0·70 fr.	0·90 fr.
From 201 to 400 kilometres . . .	0·55 —	0·70 —	0·90 —	1·15 —
Beyond 400 kilometres	0·90 —	1·15 —	1·65 —	2·00 —

Including delivery at address in all places where the cartage rate does not exceed 0·15 franc (1 $^1/_2$*d.*) per package.

International tariffs. — Just like the accelerated slow-freight tariff No. 50 in the case of home traffic, the accelerated slow-freight tariff No. 55, for truck-loads is the essential tool of the export traffic in Italian perishables. Thus it is this tariff which determines the international tariffs.

It is drawn up in the same form as accelerated slow-freight tariff No. 50.

The rates are for truck-loads of 10 tons, but whereas in the case of certain goods, such as oranges and lemons, fresh fruit and vegetables, the rates are applied to truck-loads of 10 tons; in other cases, such as butter, fresh meats, fats, milk, fish, poultry, raisins, etc., the rates are only applied to loads of 5 tons; any weight over and above this is charged supplementary rates per ton, fixed in the tariff.

Eggs in boxes or in baskets, and *live poultry*, benefit in addition by a special reduction of 8 per cent.

The conditions of its application are similar to those of slow-freight tariff No. 50.

We have to note the facilities given for paying the charges by means of cheques drawn on a bank acccepted by the forwarding railway.

The times allowed are those fixed by the Berne International Convention for *slow-freight* consignments with the reservation however that in calculating those times the Italian distances are reduced by 30 per cent; and this results in the following formula :

Time for service operations	2 days.
Time for conveyance, for indivisible fractions :	
In other countries, of 250 kilometres (155 miles)	2 days.
In Italy, of $\frac{250}{0{\cdot}7}$ = 357 kilometres (222 miles)	2 days.

There is the same clause of non-liability, in case of damage unless negligence on the part of the railway is proved.

On the other hand, we find here the same clause as in quick-freight tariff No. 3, referring to possible agreements between the consignors and the administration for carrying the consignments on certain through or accelerated trains.

It is a question of passenger trains other than the special perishables trains and in spite of the very careful and complete organization of the latter, the administration of the Italian State Railway still estimates at 1 per cent that part of the traffic of truck-loads of perishables which has profited by this option.

Finally, one condition favourable to this special trade authorizes the formation of full truck-loads by means of different consignments loaded during the journey, but subject to the condition of paying the rate for the full load from the point of start to that of delivery.

This slow-freight tarif No. 55 also formerly included, like slow-freight tariff No. 50 a subscription clause favouring large customers by rebates which varied, according to distance and amount of traffic, between 5 and 32 per cent of the rates. A recent reduction in the tariff has extended the benefit of these reductions to all customers.

Finally as regards the rates themselves, the Italian system is shown in the following table in which, in order to take the ordinary conditions of practice into account, we have assumed as a general thing that the actual weights carried are :

6 tons in home traffic, for a nominal truck-load of 8 tons;
8 — export — — — of 10 —

DISTANCE.	Rate per ton.						
	Quick-freight tariff.		Accelerated slow-freight tariff.				
			Home traffic No. 50.		Export traffic No. 55.		
	Consignments of up to 500 kilograms, in francs.	Consignments exceeding 500 kilograms, in francs.	Articles not marked with a star, in francs.	Articles not marked with a star, in francs.	Articles not marked with a star, in francs.	Eggs and live poultry.	Articles not marked with a star, in francs.
100	25·52	23·20	12 36	10·30	9·96	9 16	8 07
200	48·72	41·76	22·31	18·88	13·39	12·32	10·07
300	67·21	59 16	31·27	26·61	18·67	17·18	15·19
400	85·84	76·56	39·31	33·47	23·43	21·56	19·05
500	102 08	91 64	46·17	39·48	27·42	25 23	22·40
600	118.32	106·72	52·18	44·63	31·03	28·65	25·36
700	132 24	120·64	57·67	49·44	34·25	31·51	28·07
800	146·16	134·56	62 82	53·90	37 25	34·27	30·64
900	157·76	146·16	67·97	58·37	40·12	36·91	33 09
1,000	169·36	157·76	72·95	62·66	42·00	38·64	34·65

These rates are very reduced and the importance of the concessions so made by the Italian railways, particularly as regards exports, is shown in the following instances taken from the report of the general administration of the Italian State Railway to the International Refrigeration Congress.

Fresh grapes.

DESTINATION STATION.	Frontier stations.	Journey.	Starting from Naples.		
			Distance, in kilometres.	Rate per truck, in francs.	Rate per truck-kilometre, in francs.
Berlin-Anh. Dresden	Peri.	Italy	849	345·40	0·406
		Other countries	1,028	771·00	0·751
Buda-Pesth	Cormons.	Italy	926	363·15	0·392
		Other countries	645	389·00	0 603
Paris-Bercy	Iselle.	Italy	999	375·05	0·375
		Other countries	672	500·00	0·744

Fresh vegetables.

DESTINATION STATION.	Frontier stations.	Journey.	Starting from Naples.		
			Distance, in kilometres.	Rate per truck, in francs.	Rate per truck-kilometre, in francs.
Vienna	Pontebba	Italy	976	274 35	0·281
		Other countries	435	396 00	0 910
Amsterdam	Pino	Italy	973	274 35	0·281
		Other countries	1,053	612·00	0 581
Berne	Pino	Italy	973	274·10	0·282
		Other countries	341	356·00	1·043
Munich	Peri	Italy	849	254·50	0·299
		Other countries	412	360 00	0 873
Paris	Iselle	Italy	999	277·05	0 277
		Other countries	672	500·00	0 744

Thus the Italian railways make real and very great sacrifices on behalf of this perishables traffic. We shall consider, at the end of this chapter, how much these sacrifices have contributed to the final result and how much in general reductions in the tariffs can *a priori* influence this special traffic.

FRANCE.

Home tariffs. — In the general considerations which we discussed at the beginning of this chapter, we mentioned the particular position of France as regards traffic in seasonal articles, on account of the different climates in different districts, differences much greater than, for instance, in Germany with its continental climate, in Italy which everywhere has a Mediterranean climate; we hence concluded *a priori* that logically the French rates should be higher, at least during the early-vegetables period. Extending this idea, we drew attention to the fact that the different French railway systems could be distinguished according to their geographical orientation in latitude (Eastern, Western, Midi) or in longitude (Paris-Lyons-Mediterranean, Orleans), and that it logically followed from their situation that the former should, at least as far as seasonal traffic is concerned, have lower rates than the latter.

Now although probably this kind of geographical law was not realized from the beginning, yet it has been followed instinctively and experience has fully

confirmed it. In the case of fruit and vegetables, the tariffs of the first three railways contain much more favourable conditions, as is shown in the following table :

1. *Fruits.*

DISTANCE.	Eastern, towards Paris.	Midi, accelerated slow-freight.	Paris-Lyons-Mediterranean.		Orléans.	
			Truck-loads.	Truck-loads of 5 tons.	Truck-loads.	Truck-loads of 5 tons.
Kilometres.	Francs.	Francs.	Francs.	Francs.	Francs.	Francs.
100	19·50	24	24	24	24	24
300	47·50	48	69	69	69	69
500	75·50	80	111	96	96	90
700	...	112	130	115	115	109

2. *Vegetables.*

DISTANCE.	Western accelerated slow-freight.	Paris-Lyons-Mediterranean.			Orléans.			
		Truck-loads.	Truck-loads of 5 tons.	Periodical tariff.	Truck-loads.	Truck-loads of 5 tons.	Periodical tariff.	Periodical tariff truck-loads of 5 tons.
Kilometres.	Francs.	Francs.	Francs.	Francs.	Francs.	Francs.	Francs.	Francs.
100	16	16·50	16·50	...	16	15	11·20	10·50
300	44	48·00	48·00	47	48	44	33·60	30·80
500	52	76·00	76·00	67	80	72	56·00	50·40
700	57	101·00	90·00	80	102	90	71·40	63 00

In the second table, we give for the Paris-Lyons-Mediterranean and the Orleans railways the rates resulting from the seasonal tariffs, that is to say, from the reductions made at the end of the special early-vegetables period, when production has become more general, and needs can be satisfied on the spot, and when the selling prices accordingly become more uniform and no longer show differences greater than the cost of carriage, which previously had made it profitable to send the articles from one place to another.

We may at once state that the results of this tariff have been satisfactory on the

Orleans system at least, as far as we can judge by the comparison of years when there were great differences in the climatic conditions, that is to say when some seasons were early and some were late, when sometimes there were very rich harvests and sometimes the reverse.

For instance, this seasonal tariff was started in 1905 as regards green peas; now if we complete the results obtained since 1899 in the years when the season started after May 1, that is to say, if we leave out the other years when conditions were more abnormal, we obtain for the traffic to Paris the following table of the results obtained :

YEAR.	Season.		Tonnage.			
	Beginning.	End.	Total.	Before 1 June.	After 1 June.	Per cent.
			Tons.	Tons.	Tons.	Tons.
1900	5 May.	19 June.	4,631	4,055	576	12
1901	8 —	25 —	2,732	1,589	1,143	42
1904	3 —	23 —	5,551	4,530	1,021	18
The seasonal tariff came into force 5 June 1905; the season was already very advanced.						
1905	1 May.	22 June.	5,484	3,375	2,109	38
1906	10 —	22 —	3,428	1,545	1,883	55
1907	14 —	20 —	4,634	1,995	2,639	57
The differences are still more characteristic if we consider the special consignments sent from the southern sections of the system.						
1900	5 May.	19 June.	3,630	3,481	149	4
1901	8 —	25 —	1,162	977	185	16
1904	3 —	23 —	2,908	2,808	100	3
See the remark above.						
1905	1 May.	22 June.	2,828	2,420	408	14
1906	10 —	22 —	1,634	1,030	604	37
1907	14 —	20 —	2,561	1,654	907	35

Allowing always for the variations in the yields of the different years, it certainly seems that the results definitely justify the formula to which logic had led.

After the discussions of the extra-parliamentary commission already mentioned, the French administrations were led to readjust the tariffs applied to the perishables traffic, and except as regards some differences of detail on certain railways,

particularly as regards seasonal reductions, they finally arrived at the following formula :

NAME OF MERCHANDISE.	Scale applicable per consignment of at least 50 kilograms or paying for that weight.	Scale applicable per truck-load of at least 5,000 kilograms [1] or paying for that weight.
§ 1. — Live animals, in cages or baskets, of the following descriptions : lambs, quails, kids, guinea pigs, sucking pigs (not weighing more than 30 kilograms each, package included), snails, rabbits, pigeons, tortoises, poultry, butter, cheese, fats (margarine, lard, fresh suet), milk, yeast, eggs	A.	B.
Fruits other than grapes [2]		
Dead game, meat, dead poultry		
§ 2. — Grapes.	B.	C.
§ 3. — Mushrooms, gherkins, vegetables, melons.	D.	E.
§ 4. — Shell-fish, lobsters and crabs, oysters, mussels, fresh fish .	E. [3]	

[1] When the load in the wagons exceeds the minimum weight of 5,000 kilograms, the rates of scales B, C and E are reduced by one tenth for the excess weight.
[2] The scales B and C apply to all fruit, carried from any one station to any other station on the State, Northern, Orleans and Western systems, subject to the condition that at least two of these systems are concerned.
[3] To Paris only as far as consignments from the Midi system are concerned.

—		Scales. A.	B.	C.	D.	E.
		Francs.	Francs.	Francs.	Francs.	Francs.
Up to 100 kilometres, per kilometre . .		0·24	0·24	0 24	0·24	0·24
For each kilometre beyond	100 up to 200 kilometres	0·225	0·225	0·225	0 225	0·20
	200 — 300 —	0 225	0 225	0·225	0·135	0·13
	300 — 400 —	0·21	0 16	0·11	0·13	0·11
	400 — 500 —	0·21	0·11	0·10	0·10	0·10
	500 — 600 —	0·10	0·10	0·10	0·10	0·07
	600 — 700 —	0 09	0 09	0·09	0·09	0·05
	700 — 800 —	0·05	0 09	0·09	0·08	0·05
	800 — 900 —	0·05	0·06	0·06	0·05	0·05
	900 — 1,000 —	0·05	0·06	0·06	0·05	0·05
	1,000 kilometres.	0·05	0·05	0·05	0·05	0·05

	Scales.				
	A.	B.	C.	D.	E.
	Francs.	Francs.	Francs.	Francs.	Francs.
The scales accordingly give the following rates : for 100 kilometres	24·00	24 00	24·00	24·00	24 00
200 —	46·50	46 50	46·50	46·50	44 00
300 —	69·00	69·00	69·00	60·00	57·00
400 —	90·00	85·00	80·00	73·00	68 00
500 —	111·00	96·00	90 00	83 00	78·00
600 —	121·00	106·00	100·00	93·00	85 00
700 —	130 00	115·00	109 00	102 00	90 00
800 —	135·00	124 00	118·00	110·00	95·00
900 —	140·00	130·00	124·00	115 00	100·00
1,000 —	145 00	136 00	130·00	120·00	105 00

This French tariff differs from the tariffs of other countries, especially from the German and the Italian tariffs, by the classification of the goods into a larger number of separate classes, not only in the case of truck-loads, but also in that of broken loads. This division is in agreement with the ordinary principles of tariff-making in France, and has more especially the object of limiting the application of reduced rates to the articles only which would probably be influenced thereby, and of proportioning the amount of reduction to the presumed needs of those articles.

The knowledge which we have now acquired about the progress of these special transports, shows in fact that although there are traffics such as that of sea-fish, fruit and vegetables, which the railway can influence, there are other cases, such as meat, where reduced rates as a rule only result in sacrifices without any compensating advantages, and the recent negative experiences in Germany and Austria, fully demonstrate this.

This observation must, however, be only taken in a general sense, for particular conditions can, even in the case of these goods, make the reduction of rates advantageous. Such would, for instance, be the case with meat; in this case one might, quite apart from any idea of increasing the consumption, be led to examine the question of reducing the tariff with the sole object of inducing a change in the business by giving a preference to such meat transports as compared with transports of live animals, where there are always difficulties.

As regards the conditions of liability, we gave at the beginning of this chapter

particulars of the difference between the principles adopted in France and those adopted in other countries; in order to make this matter more clear, it seems useful to reproduce those of the conditions under which this new tariff is applied which deal more especially with this liability :

Condition of the goods. — The perishables must be sent in such a condition as to be able to stand an extra period of twelve hours, without deterioration from over-ripeness or staleness.

Rates and times. — The carriage of perishables, for which the consignor has claimed the benefit of the present tariff, is effected by trains specially designated by the administrations, the time-tables of which are brought to the knowledge of the public.

In the absence of any indication of route, the carriage is considered as having been effected by the shortest route and rated accordingly; the time allowed is calculated as by that route.

If the consignor indicates a given route, the rate and the time allowed are calculated as by that route.

The consignor also has the right to limit himself to the demand for the quickest route; in that case, the railway administrations must determine what combinations of trains give the quickest route; the rate and the time allowed are calculated as by that route. But the consignor must have advised the forwarding station, in writing, at least twelve hours before handing in his goods, the night hours not being counted, and informed it at what time he is actually going to hand in the goods.

Exceptionally, as regards certain given relations brought to the knowledge of the public, the railway administration may effect the carriage of goods, of their own accord, by certain trains on other deviated routes, applying the rates for the short route, and calculating the time allowed from the time-tables of those trains.

Perishables, for which the present tariff is claimed, are forwarded by the first train which starts after the time the consignment has been handed in and which runs : *a*) on the short route (or the deviated route if it has been officially indicated; *b*) on the route named by the consignor or on the quick route, if the consignor has asked for this.

The stations are not bound to accept for any given train any consignments handed in less than three hours before the train starts.

The refusal of their acceptance must be recorded by an early entry on the way-bill; in the absence of any such entry, the carriage is considered to have been effected by the first train named, the time of starting of which follows the hour at which the consignment is handed in under the conditions mentioned above.

If any extra trains are run, duplicating, triplicating, etc., the train named, the consignment is always considered as carried by the last of those trains.

When the carriage at a point of exchange between two systems is not effected by one and the same named through train running over both these systems, the extra time allowed for passing, by the trains named, from one system to the other is fixed at : *a*) one hour, if the station is a joint station of the two systems; *b*) three hours when the transfer is between two separate stations of the same locality, with communication by rail; except in the case of Paris, where the time allowed is six hours.

Delays. — In case of a delay of three hours actually prejudicial to the consignors or to the consignees, there is a reduction in the rates charged, under the following conditions :

a) for a delay of three to four hours, one third of the rate can be retained; *b*) for a delay of more than four hours, two thirds of the rate can be retained; *c*) for a delay of more than six hours, the whole of the rate can be retained.

Delays of less than three hours give rise to no reduction. On the other hand, the right of consignors and consignees are reserved in cases in which the delay exceeds twelve hours.

The tariff which has just been reproduced and discussed, and applicable chiefly to commercial traffic, will no doubt be soon supplemented by a tariff for small packages of farm produce, packages for supplying families or small retail firms.

This tariff which now awaits the approval of the higher authorities, has the following form :

DISTANCE.	Weight of package		
	up to 20 kilograms.	from 21 to 30 kilograms.	from 31 to 40 kilograms.
	Francs.	Francs.	Francs.
Up to 100 kilometres. .	1·50	1·50	1·50
from 101 — 150 — .	1·50	1·50	2·00
— 151 — 200 — . .	1·50	2·00	2·50
— 201 — 300 — . . .	2·00	2·75	3·25
— 301 — 400 — . .	2·50	3·50	4·25
— 401 — 600 — . .	3·00	4·25	5·25
— 601 — 900 — . .	3·50	5·00	6·50
above to . . 901 — . .	4·00	5·75	7·50

These small packages of farm produce weighing 10, 20, 30 or 40 kilograms (22, 44, 66 or 88 lb.) or paying for that weight already benefit on the State Railway by a special tariff the rates of which are paid by means of stamps stuck on to the packages by the consignors; as the rates of these tariffs are those of the *general* tariff for perishables, the only advantage is that it is possible to send fractions of the 50 kilograms (110 lb.) which form the minimum weight in the general tariff.

In spite of this advantage, this tariff is utilized but very little.

Seasonal tariffs. — With the same idea of adjusting the tariffs to commercial needs, the French railways and especially the Orleans Railway have during the last few years rather extensively instituted seasonal tariffs for perishables.

The working of these tariffs has been explained above, in the case of vegetables, and the results have been given.

The Orleans Railway has similarly applied, with a certain amount of success, a summer tariff for the carriage of eggs from the south to Paris, eggs which will more actively compete during the hot season with the eggs of the regions further north.

Another summer tariff has made less burdensome for the producers the quick-freight carriage of cheeses, which cannot, on account of the heat, be sent in winter by slow-freight rates.

EXPORT TARIFFS.— The same work of the Extra-parliamentary Commission resulted in an export tariff in which all the French companies join, and which is now the principal tool of such exportation.

We reproduce below that part of this tariff giving the rates, the conditions of application being similar to those of quick-freight tariff No. 114, the chief features of which we have given above.

NAME OF MERCHANDISE.	Scale applicable		Scales applicable to consignments leaving France by a land frontier and going to Belgium, the Grand Duchy of Luxembourg, Alsace-Lorraine, Germany, Switzerland, and to the countries beyond.	
	Per consignment of at least 50 kilograms	per truck-load of at least 5,000 kilograms	per consignment of at least 50 kilograms	per truck-load of at least 5,000 kilograms
	or paying for that weight.			
Live animals (lambs, quails, kids, guinea pigs, sucking pigs, not weighing more than 30 kilograms each, package included), snails, rabbits, pigeons, tortoises, poultry in cages or in baskets, dead game, meat, dead poultry. . .	M	N	...	...
Fruit.	M	N	N	O
Butter, cheese, fats (margarine, lard, fresh suet), milk, yeast, eggs. . . .	N	O	...	...
Mushrooms, gherkins, vegetables, melons	N	O	O	P
Shell-fish, oysters, mussels, crustaceans (crabs, shrimps and prawns, crayfish, lobsters, spring lobsters), fresh fish .	P	...	...	...

N. B. — As regards fruit and vegetables leaving France by a land frontier, there is a reduction of $^1/_{10}$ in the rates of scales O and P for consignments per truck load of at least 5,000 kilograms or paying for that weight, carried in refrigerator vans belonging to private owners or in company's vans equipped at the cost and by the care of the consignor, with racks and removable framing.

When the load in the van exceeds the minimum of 5,000 kilograms, the rates of scales N, O and P are reduced by $^1/_{10}$ for the excess weight.

RATE PER TON.		Scales.			
		M.	N.	O.	P.
		Francs.	Francs.	Francs.	Francs.
Up to 100 kilometres, per kilometre		0·20	0·20	0·20	0·16
For each kilometre beyond	100 up to 200 kilometres	0·18	0·16	0·11	0·11
	200 — 300 —	0·14	0·12	0·11	0·11
	300 — 400 —	0·13	0·12	0·11	0·11
	400 — 500 —	0·13	0·12	0·10	0·10
	500 — 600 —	0·12	0·10	0·09	0·06
	600 — 700 —	0·11	0·10	0·07	0·05
	700 — 800 —	0 09	0·09	0·06	0 05
	800 kilometres	0·05	0·05	0 05	0 05
The scales accordingly give the following rates :					
For 100 kilometres		20·00	20·00	20·00	16·00
— 200 —		38·00	36·00	31·00	27·00
— 300 —		52·00	48·00	42·00	38 00
— 400 —		65·00	60·00	53 00	49·00
— 500 —		78 00	72·00	63 00	59 00
— 600 —		90 00	82·00	72·00	65·00
— 700 —		101·00	92·00	79·00	70 00
— 800 —		110·00	101·00	85·00	75 00
— 900 —		115·00	106 00	90·00	80 00
— 1,000 —		120·00	111·00	95 00	85.00

This tariff has an interesting peculiarity; the rates for exports crossing the frontier by land are lower than those by sea.

Always with the object of limiting sacrifices to what is really useful, it has in fact been thought that considering the general state of the traffic, it was above all advisable to try and reduce the rates to Germany, if not to the level of the Italian export tariffs, at least to reduce the difference as compared with the latter.

We also have to note the reduction of $^1/_{10}$ in the rates in order to encourage the sending of consignments in refrigerator vans or other vans equipped so as better to keep the articles fresh.

Finally, a new proviso authorizes the public to demand the *quickest* route for its consignments, paying naturally the rate of the scale calculated according to the length of that route.

It is not necessary to lay stress on the advantage it is to this perishables traffic to depart from the usual rule of the direct route. It would even be quite desirable to see it introduced into the conventions relating to international traffic subject to the provision, if necessary, of measures of compensation for the direct route deprived of this traffic.

This tariff which applies to joint transport on all the lines also regulates the exports proper of each administration.

We have, however, to mention a very reduced rate of the French Northern Railway for exports of sea-fish to Belgium and the countries beyond, and also the reduced quick-freight and slow-freight tariffs of the Midi Railway to Bordeaux, in order to deflect through that port the consignments to England which otherwise would go from south to north and by the Channel ports.

These Midi tariffs give for instance from Agen to Bordeaux reduced quick-freight and slow-freight rates of 23·05 and 9·90 francs (18*s*. 8·83*d*. and 8*s*. 0·57*d*. per English ton) respectively, while the rate from Agen to Boulogne is 106·90 francs (£4.6*s*. 10·71*d*. per English ton); moreover, the shipping rate from Bordeaux is also very much reduced.

In spite of this enormous advantage only mediocre results are obtained, and the same applies to attempts made by the State Railway to deflect the traffic and attract it to La Pallice, by applying the lowest of their slow-freight tariffs to consignments nevertheless carried on their fastest trains.

These are further proofs that the question of the cost of carriage is far from the most important one for this traffic, but that the conditions of speed and regularity of the conveyance are in reality the essential conditions.

International tariffs.— The export tariff, or an analogous tariff of the Paris-Lyon-Mediterranean, is combined with the Swiss and the German tariffs to form the Paris-Lyons-Mediterranean-German tariff, the through rates of which are obtained by combining the rates of the different countries.

In the case of consignments for Germany, coming from the Western and Orleans systems, those railways and the French Northern Railway had to take into consideration the crossing of Belgium; they have charged themselves with the cost of this crossing and simply extended the rates of their tariffs from the Belgian-German frontier station Welkenraedt to the Belgian-French frontier station Jeumont; this comes to the same thing as reducing their rates to the latter station by the amount

of the Belgian rates : 15·82 francs (12*s.* 10·31*d.* per English ton) for broken loads, 12·53 francs (10*s.* 2·22*d.*) for truck-loads of 5,000 kilograms (11,000 lb.).

Slow-freight rates in combination with the shipping companies and with the English railways facilitate the export to England by the Channel ports, of the eggs from the Bourbonnais and the Auvergne, of the new potatoes from the Paris-Lyons-Mediterranean system and from Algiers, and especially the transit of Italian produce for which those tariffs with very reduced rates equalize the combinations obtained by lines outside of France and going to Ostend and Antwerp.

Reduced quick-freight tariffs, in combination with the shipping companies, facilitate the import into or the transit through France of the perishables from Algiers.

These tariffs are made by simply combining the shipping rates with the rates of the ordinary Paris-Lyons-Mediterranean tariff from Marseilles or Cette; their chief object is to enable the public to send packages direct from Algiers.

Other tariffs in combination with the Spanish railways, deal with the consignments of fruit and vegetables sent from that country to Bayonne, Cette, Bordeaux, Toulouse, Marseilles, Lyons and Paris, or with the consignments of live poultry and seafish sent from France and Catalonia and Valencia. The formers tariffs, which have been in force a very long time, give comparatively high rates of which the following are some examples :

JOURNEY.	Distance.	Vegetables.	Fruit.
Granada to Paris	2,141 kilometres.	420·90 francs.	
Valencia to Paris	1,485 —	314·85 francs.	324·05 francs.
Seville to Bordeaux	1,458 —	293·25 francs.	
Madrid to Paris.	1,452 —	277·45 francs.	
Alicante to Lyons	1,273 —	282·35 francs.	294·85 francs.

We have seen above that the amount of traffic carried under the conditions of this tariff is comparatively very small.

Having now arrived at the end of this examination of the principles adopted in the different countries when making perishables rates, it must be recognized that it fully confirms the existence of the double tendency mentioned at the beginning of this chapter, on the one hand of reducing the rates, the carrier being relieved of all liability, and on the other hand of granting to the public the speed and the guarantees which it demands above all, subject to greater reserve in the reduction of rates.

It is impossible to say *a priori* which of these two points of view is the better; so

many different factors come into play in the variations in this special kind of traffic.

For instance, let us take the case of the Italian railways, which as we have seen, make very considerable sacrifices; can we really believe that the growth of their export traffic is solely due to the reductions in their rates? Is not a great part of it due to other happy circumstances which have arisen simultaneously?

To the considerable development of the needs of Central Europe owing to the growth of its population (Germany has 23 million inhabitants more than in 1870),

To the industrial prosperity and the extension of the general welfare?

To the closer political relations with that country?

To the prolonged neglect of French traders and producers?

To improvements in business and transport methods, etc.?

Can we not also raise as objection to the theory of the superior efficiency of the lowering of rates, the very considerable progress of French exports although the rates for carriage are higher, and that in Germany itself, in spite of the Italian competition favoured by much more advantageous rates for carriage?

The failure of the very reduced tariff applied in Germany and in Austria to meat, in spite of the importance (50 per cent) of the reduction?

The mediocricity of the results of the attempts made to divert to the western ports the fruit going from the south of France to England?

The failure of the reduced Italian tariffs to enable Italy to compete with French fruit on the English market? And so on.

Actually the progress of this particularly-sensitive traffic is not only affected by the conditions which depend on the railways (rates, speed, punctuality, liability, etc.), but also and above all by those which depend on trade and production, quality, selection, condition of the produce; and it is impossible to determine even approximately only the influence of each of these factors.

However, it would not be reasonable to assert that the traffic is not affected by the rates for carriage and that these can be kept at a high level.

Apart from the fact that a prohibitive level would soon be reached, we have seen that judiciously-constructed tariffs have produced good results.

But in such cases, it is a question of limited measures to meet with ascertained wants; were a general reduction to be considered, a recent experience would enable us to measure the importance of the results which could be expected and to see whether these results would sufficiently compensate for the risks run.

From this point of view, we can consider the extensive experience gained on the French railways in 1892, when the tax of 23·2 per cent which was then levied on all quick-freight traffic was repealed. The railways simultaneously reduced their rates, to an extent which, as far as perishables were concerned, amounted on the Orleans Railway to from 30 or 35 per cent, or say by about $^1/_3$ of the former rate.

In the absence of general statistics, the statistics of this railway enable us to compile the following table showing the progress of its perishables traffic both before and after 1892.

Total perishables traffic on the Orleans Railway.

YEAR.	Before 1892.		YEAR.	After 1892.	
	Tonnage.	Receipts, tax included.		Tonnage.	Receipts.
	Tons.	Francs.		Tons.	Francs.
1885	92,400	5,612,000	1893	137,800	6,796,000
1886	97,900	6,215,000	1894	130,200	6,192,000
1887 . . .	99,100	6,355,000	1895	146,600	6,513,000
1888	99,600	6,215,000	1896	163,100	7,126,000
1889	102,400	6,290,000	1897	179,100	8,215,000 (1)
1890	97,400	5,855,000	1898	184,300	8,158,000 (1)
1891	102,400	6,165,000	1899	204,200	9,127,000 (1)

(1) Establishment of the post-office tariff for 10-kilogram parcels.

1892. — Tonnage : 102,300 tons. — Receipts : 5,850,000 francs.

	1885-1891.		1899-1893.		Increase.	
	Tonnage.	Receipts.	Tonnage.	Receipts.	Tonnage.	Receipts.
	Tons.	Francs.	Tons.	Francs.	Tons.	Francs.
Average results of each period	98,700	6,012,000	163,600	7,447,000	64,900	1,435,000
Differences (1)	10,000	553,000	66,400	2,331,000	56,400	1,778,000
Annual average progress in each period	$\frac{10,000}{6} = 1,667$	$\frac{553,000}{6} = 92,200$	$\frac{66,400}{6} = 11,067$	$\frac{2,331,000}{6} = 388,500$	9,400	296,000

(1) Between the results in the extreme years.

The immediate increase in 1893 was evidently not wholly the effect of the new tariff, but was rather due to the fact that certain articles formerly sent as slow freight were now, in consequence of the lowered rates, sent as quick freight; the variations which take place in the annual yield have also to be taken into consideration.

But the much greater and moreover regular progress of the traffic in the second period certainly has to be attributed to the new tariff. This faster progress amounted to an increase of 9,400 tons in the average annual progress, and of 64,900 tons for the whole of the second period.

As compared with a tonnage of about 112,000 tons, which would have resulted in 1899 if the former average increase of 1,667 tons had been kept up, this additional increase of 64,900 tons obtained in six years, marks an increase of about half, and, with all the reservations which such a calculation evidently involves, it seems that we can approximately take this 50 per cent as a measure of the effect of the new tariff.

This is no doubt a very appreciable result; it does, however, seem disproportionate to the considerable effort which a reduction of one third in the tariffs represents, and on the other hand, from the financial point of view, which also must not be neglected, the operation has resulted in no real profit.

The sacrifice made on the basis of the 1891 receipts represented in fact about 1,550,000 to 1,700,000 francs (£62,000 to £68,000); as we can see in the table, this is nearly exactly the gain, 1,778,000 francs (£71,120), which has been realized at the end of six years, by the fact of the more rapid growth of the traffic; with this further reservation that the loss represented *net* receipts while the gain is only in *gross* receipts.

These results are thus really very mediocre and unsatisfactory; although the reductions in the rates were great and could hardly be repeated, they seem to prove definitely that little is to be expected from systematic reductions applied on principle to all the rates.

Actually it is with this special traffic as with any other : reductions in rates are a question of expediency and opportunity; as in the case of all other kinds of traffic, the railway administrations must attentively watch the progress of the different items which make up their perishables traffic, studying the needs with constant attention, so as to intervene when this is necessary, and decide at the right time in accordance with the tendencies which make their intervention necessary.

Apart from the principal questions concerning the rates and the liabilities, there are also some minor points in connexion with perishables traffic, of which it will be useful to give a short summary.

The return of empty packages. — Returned empties are carried on slow-freight trains at exceptionally-reduced rates on most of the railways; some of them even, like the Northern and the State, carry them free of charge.

The amount of the reduction varies; we quote the following instances from the documents annexed to the answers sent by the different administrations :

Germany. — Application of the broken-load tariff, *at half the real weight*.

Switzerland. — Application of the special perishables traffic.

Belgium. — Application of the rates of the first class of the general slow-freight tariff.

France. — Free on the Northern and on the State; on the other lines application of reduced tariffs similar to the following tariff of the Orleans Railway :

For any consignment from 0 to 25 kilograms (from 0 to 55 lb.)	0·25 franc (2 1/2 *d.*).
— — weighing over 25 kilograms (55 lb.) per indivisible fraction of 10 kilograms (22 lb.)	0·10 franc (1 *d.*).

This question of returned empties is a very burning one in England owing to the difficulties which the purchaser has with these packages, in the way of collection, storing, sorting, checking, etc. An active agitation is in progress in favour of packing the goods in *non-returnable packages*, and the railways have been asked to support this agitation by specially favouring the carriage of goods in non-returnable packages.

On the other hand, the middlemen who at present profit by the hire of their baskets, etc., are naturally against these new measures.

This service of returned empty baskets, for carriage on all railways, does not present any greater difficulties than any other goods, for the sorting is effected at the start by the consignors of those empty packages; but it on the other hand gives considerable trouble and difficulty to the seaport stations which receive these empty packages from England; it is quite intelligible that the railways which operate these stations have every desire to get rid of this trouble, particularly if they carry the empties free of charge, like the French Northern Railway.

Finally it may be feared that the trade, with a view to economy, will show a tendency to reduce the weight and strength of the new non-returnable packages as far as possible, to the detriment of the preservation of the goods and to the prejudice of the railway which charges on the gross weight.

Thus the question as it stands is rather complicated. It would no doubt be impracticable to reduce all the old tariffs with an eye to this new state of affairs; but in the case of new tariffs it will likely be possible to examine whether it is advisable to reserve their application to the non-returnable empties, as has been done by the French administrations in their recent export tariff, in the case of goods carried in refrigerator vans or specially-arranged vans and therefore benefiting by a reduction of rate of 10 per cent.

Tariffs between countries having different monetary systems. — Combined tariffs with through rates made by different countries may meet with difficulties either because although the monetary systems are the same the fluctuations in exchange may alter the relative values in some of those countries, or because the monetary systems are different, as in the case of the French-German-Russian tariffs which unite three countries having as their monetary units the franc, the mark and the rouble respectively, and in that of the French-Spanish-Portuguese tariffs whence the corresponding countries have as unit the franc, the peseta, the milreis.

The complications are of two kinds; firstly, with the public from the point of view

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of the settlement of the charges for the carriage; secondly, as regards the adjustment of accounts between the railways concerned.

1° *The point of view of the public :*

In the case of tariffs with several currencies the most usual practice is to advise the stations concerned periodically of any alterations in the exchange; the amount to be paid is then calculated by converting on this basis the rate or charge of the tariff into the currency of the country where the payment is made.

However different practices also exist :

The Italian-English tariffs consist of fixed prices to London calculated in gold; when there is a premium on gold, as regards Italian paper and money, the railway is authorized to demand the payment in gold of the foreign share of the charges.

The combined French-Spanish tariffs are based on fixed prices given in francs; in order to take the rate of exchange into consideration, it is specified that Spanish consignors must before despatching pay the Peninsular share in pesetas, the French share in francs being collected on arrival. In this way, no adjustment of accounts between the two countries is necessary, as each has received what is due to it; but it is evident that this very simple system which makes it necessary for the consignor to pay out money before his goods are sold, is from the commercial point of view decidedly inferior to the previous one.

This commercial point of view should however not be left out of consideration, and we may assume that it is in order not to give trade the trouble of keeping accounts in two different systems that the German-Italian tariff has been made with the Italian share in lire and the German or Swiss-German share in francs.

2° *The point of view of the adjustment of accounts between the administrations concerned :*

Two systems of adjustment are very usual :

a) By one of the administrations concerned;
b) By a clearing-house kept at joint expense.

a) The first may in certain cases present disadvantages. A rather long interval always elapses between the receipt of the payments for the carriage and the making-up of the accounts. Now in certain countries the exchange fluctuates a good deal. If during that interval the exchange goes up, the administration acting has to pay more than it has received; the contrary is the case if the exchange goes down. Thus it has happened to the Orleans Railway with the French-Spanish-Portuguese tariff, that during a long time the milreis was continually rising till it stood nearly at par; the Orleans Railway which had to purchase from banks the drafts necessary for paying their share to the Portuguese companies as a result suffered successive losses, the total amount being comparatively large. It is true

that the fall in exchange which has occurred since has chanced to compensate it to some extent, but this system nevertheless shows peculiarities which make the clearing-house system preferable.

It is such an international clearing-house established at Brussels, which for instance liquidates all the accounts concerning the joint through traffic of England, France, Holland, Belgium, Germany, Switzerland, Austria-Hungary, Italy. This office sets the debits and the credits of the different administrations against each other, and adjusts the balance sin the most economic way, taking the exchanges into account and reducing the movements of cash to the minimum possible.

One can conceive that if there are any important variations in the exchange, this office will distribute equitably the resulting losses or gains between the administrations concerned.

CHAPTER III.

Carriage. — Trains used. — Acceleration.

Subject to the reserve that most of the administrations, except those in France, do not enter into any real engagement to carry goods in a given time, all at all events try to reduce this time as much as possible.

Passenger trains, parcel trains, special trains during the busy seasons, are all used to carry these perishables as quickly as possible to their destination, without however using the express or fast trains especially reserved for passengers.

Everywhere regulations are issued to regulate the conveyance of these perishables.

The Belgian State and the Italian State, more particularly, have given information on this point of which the following is a summary :

Belgian State. — As regards home traffic, although the tariff does not give a *legal* right to anything except the goods trains, yet *in fact* the home traffic in milk, fresh cheese and butter is carried *on the first and last passenger trains* of the day, during the winter, the spring and the autumn months; on *all* ordinary passenger trains during the warm season, from May to September (both inclusive).

The system of the earliest and latest train is extended the whole year to dead poultry, meat, vegetables, fruit and game.

Eggs, live poultry, fresh flowers, vegetables and colonial fruit are sent by parcels or tranship trains.

Fish is conveyed by all passenger trains.

In the case of international traffic, the system is the same for these different groups, excepting that the articles only conveyed by the earliest and latest train, in the case of home traffic, are in this case conveyed by *all* passenger trains.

Moreover, the use of these passenger trains is, in a general way, prescribed for the stations at which the parcels and tranship trains do not call; the general prescrip-

tion is that the goods should arrive at the exit frontier station *before noon* of the day after the consignment has been handed in at the forwarding station, or in the case of transit goods, at the entrance frontier station.

Italian State. — We have already mentioned the great care taken of this special traffic; this railway has worked out a very complete and very detailed plan for the carriage of this traffic. This plan is based primarily on the running of four chief pick-up trains.

The *Tyrrhenian*, or GG, which runs along the Mediterranean coast;

The *Adriatic*, or PP, which runs along the Adriatic coast up to Bologna;

The *Ionian-Adriatic*, or TT, for lemons and oranges from Sicily;

The *Paduan*, or 5066, for the farm produce of the northern districts.

Other definite trains can eventually be substituted for these chief trains; the trains on secondary lines also act as feeders.

A very clear diagram (reproduced in appendix 3) shows diagrammatically the whole course of this special traffic.

In the other countries, in Germany, Spain, Holland, Austria-Hungary, Russia, France, most of the railway systems have special time-tables for this traffic, some of them very extensive; for instance, that of the *Bavarian State*, which is in nine parts.

In *Siberia*, in the case of butter exported by the Baltic ports, the plan for the conveyance is drawn up in accordance with information supplied by the parties concerned as to their probable shipments.

Nearly over these time-tables are as a rule not issued officially to the public which only receives information, without any guarantee, when it asks for it.

In *France*, this special time-table is sold to the public.

In *Holland*, *Austria-Hungary*, *Russia*, the publication is effected by posters, at least as far as certain services are concerned. It is to be noted that the posters of the *Dutch Railway Company* announce in large letters that these time-tables are not guaranteed; this guarantee is limited to the legal times allowed only.

According to the *administration of the Austrian North Western and the South Northern*, the use of the ordinary and express trains is regulated by special agreements with the contracting parties.

The time-tables being thus everywhere accurately fixed, it is necessary to make certain that they are adhered to.

Except in the case of the *Italian State Railway*, the information supplied by the different administrations does not refer to any organization of a specially-controlled system for this traffic.

In *Germany*, the wagons loaded with these perishables have labels placed on them indicating the successive trains which are to be used.

Moreover according to paragraph 32 of the general traffic regulations, in order to ensure the transit of wagons conveyed by the trains named, certain stations are instructed in a general way to send to the sorting stations or to the nearest large stations special telegraphic advices which enable them to prepare for the marshalling of their trains; the wagons containing quick-freight goods are naturally placed at the head of the list of wagons which is sent on in this way.

In *France*, on the Orleans system for instance, the important marshalling stations such as Paris must at once point out the irregularities both to the district department to which the station in fault belongs, and to the central administration; they must watch very closely not only over the proper conveyance of the goods, but also over the proper transmission of the papers, which are perhaps more liable to be delayed or go wrong, and without which delivery on arrival might be delayed.

In *Austria*, a special prescription shows all the interest attached to the proper and regular conveyance of this traffic; this is the order to delay every wagon which has gone wrong or is out of order so that it may be added at the next passage of the regulation train.

In *Siberia*, consignments loaded on slow-freight trains must be advised the whole way by telegraph.

In *Italy* finally, the regularity of this carriage of perishables is considered of such an importance that both on the whole system and at the central administration there has been created an organization of control which it appears interesting to consider.

The forwarding station must for each wagon of perishables starting there fill up a detailed route-bill, form G 167, giving in accordance with the general route regulations, the principal stations of the route, together with the indication of the trains to be joined, and the time of arrival and of departure at those stations.

This form serves the conductor as an envelope for the various papers and documents referring to the contents of the wagon; it has spaces provided to receive in succession the stamps of the conductors of the different trains joined, who in this way record the receipt of the wagon.

Moreover, in the list drawn up by the forwarding station, some stations choosed record the trains really used and the real times of arrival and departure; in addition, quite apart from special reports, they eventually record on it any deviations from the prescribed route and any delay which has occurred in the journey of the wagons.

At the end of the journey the terminal station must send the bill to the central administration.

For purposes of control, and in order to ensure the proper forwarding of all these papers, certain stations have the duty of supplying a daily record (form 90) of all the perishables wagons which have arrived or have passed through, the record not being made by means of the route bills which are to be controlled, but by the wagons papers, with their labels or other matters. In addition all the irregularities which have occurred in this special traffic must be recorded.

These records are sent every day to Rome to the central administration and a

special office checks the route-bills in series and compares them with the station reports.

The service so organized is very complete; it might even be thought that it gave much work to the stations where sometimes the time might be lacking for making all these observations while the train was passing; it might also involve a considerable expense of staff.

In answer to these remarks, the administration of the Italian State Railway stated that the route-bill, which serves conveniently as an envelope for the other papers referring to the transport, in most cases requires only very little work at the forwarding station, owing to the simplicity of the routes most frequently used.

The stamping by the train conductors is an extremely easy operation.

As regards the daily reports from the stations, the work has just been simplified by the last service order of March 1909, which has limited their drawing up to the more important stations who must enter all the wagons, and to a certain number of junction stations who only record the movements on the secondary lines, for the connexions on which there is enough times.

Owing to this limitation, the work can now be done without hurry and under favourable conditions.

As regards the central administration, five employees suffice to ensure a proper check, about 6 per cent of the total route-bills being checked, the work naturally bearing on the irregularities recorded in the station records.

The efficiency of the control is moreover proved by the paucity of complaints from the public.

It is also interesting to mention that in order to avoid any inconvenience from the delay or loss of the papers, in the absence of which delivery could often not be effected at arrival, the Italian State Railway has adopted the rule of placing on the loaded wagon a duplicate of the way-bill or of the route-bill, which, should the case arise, fills the place of the actual way-bill.

This measure appears particularly useful in the case of international traffic, the special work of the customs introducing a new chance of error or of irregularity in the transmission of these papers; therefore its utility should be brought to the notice of other administrations. It would however be desirable, in order to lighten the work of the stations, which is always rather hasty and hurried in the case of this special tariff, to ask the public to draw up this duplicate.

In order to appreciate the results obtained with these different organizations, we cannot do better, we think, than give for a certain number of relations the time-tables resulting from the use of the trains designated in the running or route tables.

This information is given in the following table which is compiled either from instances given by the different administrations in their answers to the list of questions, or from documents annexed to those answers.

JOURNEY.	Distance, in kilometres.	Time (1).	Mean inclusive speed, in kilometres.	*Authority.*
		Coming from Italy.		
Bologna-Berlin	1,948	100 hour approximately.	19 to 20	Official French document.
Bologna-Pontebba	976	37 h. 0 m.	26·30	Report to the International Refrigeration Congress.
Bologna-Modane	441	27 h. 10 m.	16·20	Table C (general time-tables of the Italian State Railway). Train FF 5756 and 2002.
Bologna-Chiasso	268	13 h. 45 m.	18·18	Ditto: Train FF.
Castellamare A^{e}-Chiasso	618	31 h. 56 m.	19·30	Ditto: Train PP.
Mestre-Modane	508	37 h. 35 m.	13·52	Ditto: Train 5056 and 5010.
Mestre-Chiasso	299	25 h. 44 m.	15·25	Ditto: Train 5066.
Mestre-Pontebba	185	6 h. 16 m.	29·50	Ditto: Train MM.
Milan-Modane	251	14 h. 0 m.	18·0	Report to the International Refrigeration Congress.
Palenne-Chiasso	1,606	79 h. 0 m.	20·30	Ditto.
Salerne-Modane	1,050	68 h. 45 m.	15·30	Table C (general time-tables of the Italian State Railway). Train GG 5022 and 2002.
Salerne-Chiasso	959	44 h. 0 m.	19·36	Ditto: Train PP and FF.
		Coming from Holland and Belgium.		
Amsterdam-Bâle	744	42 h. 16 m.	17·58	According to the time-tables given by the Dutch Railway Company.
Ostende-Bâle	701	44 h. 51 m	15·60	Alsace-Lorraine book. Appendix, 5, page 186.
Ostende-Cologne	332	11 h. 25 m.	29·04	Bavarian State book. Part 1, page 139.
Rotterdam-Bâle	704	21 h. 14 m.	34·5	According to the time-tables given by the Dutch Railway Company.
Ymuiden-Bâle	760	45 h. 4 m.	16 86	Alsace-Lorraine book. Appendix 5, page 181.
Ymuiden-Bâle	760	35 h. 1 m.	21·66	According to the time-tables given by the Dutch Railway Company.
Ymuiden-Berlin	673	24 h. 7 m. to 42 h. 18 m.	15·90 to 27·9	Ditto.
Ymuiden-Paris-Nord	533	10 h. 23 m.	51·30	Ditto.
		Coming from Alsace-Lorraine, the different German States and Austria.		
Altona-Oderberg	801	40 h. 31 m.	19·74	Prussian State book. Part 2, page 234.
Altona-Breslau	617	31 h. 26 m.	19·60	Ditto.
Geestemeinde-Kufstein	912	49 h. 40 m.	18·40	Bavarian State book. Part, 1, pages 140-141-142.
Geestemeinde-Strasburg	739	49 h. 6 m.	15·0	Alsace-Lorraine book. Appendix 5, page 180.
Kufstein-Cologne	718	45 h. 30 m.	15·80	Bavarian State book. Part 1, pages 140 et 142.

(1) The time required for the journey has been calculated for the international transport without allowing for difference of meridian.

JOURNEY.	Distance, in kilometres.	Time (1).	Mean inclusive speed, in kilometres.	*Authority.*
Coming from Alsace-Lorraine, the different German States and Austria (continued.)				
Kufstein-Berlin	715	38 h. 40 m.	18·48	Bavarian State book. Part 1, pages 150 and 151.
Montreux-Vieux-Berlin (Central market)	902	50 h. 34 m.	17·80	Alsace-Lorraine book. Part 5, page 177.
Montreux-Munich	473	31 h. 30 m.	15·00	Ditto : Part 5, pages 182 and 183.
Wurzbourg-Bâle	395	8 h. 27 m.	46·70	Answer of the Baden State Railway to list of questions.
Coming from Switzerland.				
Buchs-Genève	381	31 h. 57 m.	11·90	Answer of the Swiss Federal Railway to list of questions : Eggs and poultry.
Buchs-Delle Fre.	275	19 h. 7 m.	14·40	Ditto : Eggs.
Romanshorn-Genève	348	24 h. 40 m.	14·10	Ditto : Eggs and poultry.
Coming from Russia.				
Rostoff-Kostoff	830	37 h.	22·40	Answer of the Russian South Eastern. Special summer train.
Passenger trains and mixed trains	...	...	26 to 37	Ditto : Dairy produce.
Other trains	...	...	16 to 22	Ditto : Other perishables.
Coming from France.				
Midi Railway.				
Perpignan-Jeumont	1,169	49 h. 5 m.	23·00	Information supplied by the Orleans Railway.
Perpignan-Pontarlier	879	47 h. 20 m.	18·57	Ditto : Viâ Lyon-Dijon.
Arcachon-Pontarlier	841	27 h. 29 m.	30·70	Ditto : Sea-fish.
Arcachon-Genève	805	33 h. 85 m.	24·00	Ditto.
Moissac-Bordeaux	178	4 h. 46 m	37·32	Ditto.
French Northern Railway.				
Boulogne-Marseille	1,092	23 h. 56 m.	46·00	Information supplied by the French Northern Railway. Sea-fish.
Boulogne-Bâle	766	13 h. 48 m.	31·00	Ditto.
Boulogne-Lyon	757	17 h. 9 m.	44·00	Ditto.
Boulogne-Montluçon	589	17 h. 25 m.	34·00	Ditto.
Boulogne-Nancy	516	12 h. 34 m.	41·00	Ditto.
Boulogne-Tours	497	14 h. 25 m.	34·00	Ditto.
Boulogne-Bourges	494	12 h. 38 m.	39·00	Ditto.
Paris-Nord-Calais	296	5 h. 15 m.	56·19	Ditto.

(1) The time required for the journey has been calculated for the international transport without allowing for difference of meridian.

JOURNEY.	Distance, in kilometres.	Time (1).	Mean inclusive speed, in kilometres.	*Authority.*
Orleans Railway.				
Agen-Berlin	1,704	63 h.	25·80	Information supplied by the Orleans Railway: Viâ Paris-Jeumont.
Agen-Cologne	1,149	41 h. 2 m.	28·00	Ditto.
Agen-Boulogne	915	26 h. 46 m.	34·18	Ditto.
Bordeaux-Berlin	1,631	60 h. Approximately.	27·10	Ditto: Viâ Paris-Jeumont.
Bordeaux-Cologne	1,076	35 h. 23 m.	30·40	Information supplied by the Orleans Railway.
Bordeaux-Limoges	231	3 h. 57 m.	58·47	Ditto.
Brive-Edimbourg	...	44 h. 20 m.	...	Ditto: Special service, July and August 1909
Brive-Liverpool	...	41 h. 45 m.	...	Ditto.
Brive-Manchester	...	39 h. 30 m.	...	Ditto
Brive-Londres	...	26 h. 45 m.	...	Ditto.
Brive-Boulogne	762	22 h. 11 m.	34·17	Ditto.
Montauban-Berlin	1,715	63 h.	27·20	Ditto: Viâ Paris-Jeumont.
Montauban-Cologne	1,160	38 h. 21 m.	30·00	Ditto.
Montauban-Edimbourg	...	49 h. 30 m.	...	Ditto: Special service, July and August 1909.
Montauban-Liverpool	...	46 h. 55 m.	...	Ditto.
Montauban-Manchester	...	44 h. 40 m.	...	Ditto.
Montauban-Londres	...	26 h. 45 m.	...	Ditto.
Montauban-Boulogne	925	25 h. 60 m.	36·75	Ditto.
Montauban-Jeumont	912	28 h. 46 m.	31·70	Ditto.
Montauban-Paris	662	15 h. 14 m.	41·48	Ditto.
Paris-Lyon-Mediterranean Railway.				
Avignon-Hambourg	1,395	72 h. 32 m.	19·20	Information supplied by the Paris-Lyons-Mediterranean Railway. Viâ Pagny-sur-Moselle.
Avignon-Brême	1,295	67 h. 35 m.	19·20	Ditto.
Avignon-Cologne	1,229	38 h. 41 m.	31·80	Ditto: Viâ Paris-Jeumont.
Avignon-Francfort	949	72 h. 32 m.	19·20	Ditto: Viâ Pagny-sur Moselle.
Avignon-Aix-la-Chapelle	943	46 h. 26 m.	20·30	Ditto.
Avignon-Lyon	236	6 h. 5 m.	38·79	Ditto.
Barbentane-Berlin	1,442	59 h. 24 m.	24·20	Ditto: Viâ Montreux-Vieux.
Barbentane-Boulogne	984	31 h. 43 m.	31·20	Ditto.
Tarascon-Paris	743	22 h. 37 m.	32·80	Ditto.

(1) The time required for the journey has been calculated for the international transport without allowing for difference of meridian.

CHAPTER IV.

Means of conveyance (special refrigerator vans, etc.).

The questions dealt with in this chapter includes two parts :

1° Special equipment of wagons of ordinary type;
2° Special wagons (refrigerator vans, constant-temperature vans, heated vans, etc.).

1° *Special equipment of wagons of ordinary type.*

This equipment consists most often of a set of shelves in the wagons to take fruit, and in Holland to take cheess, which are placed on trays which slide in.

Double and treble boarding is also frequently put in to wagons for carrying milk and poultry and small live animals.

In Central Europe, in Germany, Austria, Hungary, Holland and also in Russia, hooks are extensively used for hanging up quarters of meat, these hooks being permanently fixed either to the roof of the wagons or to movable cross-beams supported on equally-movable trestles.

Of this equipment part is owned in some countries by the railways, the rest being owned by traders; in other countries the whole is owned by traders.

In the former case, the part provided by the railways is of minor importance; for instance the Saxon State Railway only owns one milk van and four fruit vans equipped with shelves; the Bavarian State Railway has six wagons with meat hooks; the Belgian State Railway has three such wagons and eighteen fruit vans with shelves.

It is thus evident that the administrations cannot meet all the demands of the public, demands which are the more pressing as these gears are generally placed at their disposal free of charge. In order therefore to get rid of the demands it cannot satisfy and the complaints which ensue, the railway must be protected by its regulations; it is curious to note in this respect that this mixed system exists above all in the countries with a strong administration, such as Germany, Austria-Hungary, Russia.

Taking into consideration the habits of the public in the Latin countries and the principles of absolutely equality which are accepted there, it seems preferable that the railway administrations should not adopt this system.

We have just stated that these conveniences are nearly always placed at the disposal of the public free of charge.

In *Germany*, more especially, this absence of charge both going and returning results in a general way both for the equipment provided by the public as well for that provided by the railway, from the provisions of paragraph 56 of the general conditions of the classifications of goods.

The same rule obtains in *Austria-Hungary* and in *Holland*.

In *Russia*, on the Moscow-Brest line, the weight of this equipment is included with the goods when determining the rated weight.

On the *Transcaucasian* lines, the railway places at the disposal of the public shelves, heating apparatus, cooling apparatus, divisions. No mention is made of any charge except in the last case, where it is 2 roubles (*4s.* 3·26*d.*) per wagon.

In *Siberia*, the movable equipment with hooks for the meat is carried free of charge going; but returning a special rate is charged, which is not mentioned.

In *Russia*, as there are not enough heated wagons available the question has arisen (see *Bulletin des transports internationaux*, May 1907, p. 105) of lining the wagons either with felt, or with hay or straw to protect eggs carried during winter against cold.

The railway officials were not in favour of these operations being carried out by the public. In face of these difficulties, the Russian railway Union decided to authorize them, but reserving for themselves the right of having the felt lining put in by the railway, at the expense of the public, for otherwise the operation might damage the rolling stock.

In the countries where the railways have nothing to do with the provision of such equipment, a rather usual system, for instance in Belgium and on some French lines, consists in charging for the weight of the fruit plus the weight of the shelves used for the carriage of the fruit, and to return them either free of charge (Belgium) or at the reduced rates for returned empties (France).

The French Western Railway however carries them free of charge up to a weight equal to one eighth of the whole rated weight.

It seems that the system of charging for their weight, that is to say, treating them like other packing, holds an equitable balance between the customers who use such equipment, and consequently can materially reduce their packing, and the customers who use the ordinary method, as these would otherwise pay more on their packing and would thus be prejudiced.

This system has, moreover, not prevented the development of the use of wagons with such shelves; for in the case more especially of grapes which it particularly suits, about one quarter of the wagons arriving at the Paris-Orleans station are so equipped.

It must be added that their use and the consequent handling makes it necessary to have more ground available at the arrival stations. Now, especially at large stations and at the time when much fruit arrives, the quick-freight stations have only limited grounds available and this is a fact which must be allowed for when considering the questions concerning transport in carriages so equipped.

However this may be, the use of such shelving makes it possible to carry delicate fruit, such as strawberries and grapes, long distances under much more favourable conditions.

Subject to the reserves mentioned above, it should therefore be encouraged and it is for this purpose that the French export tariff provides a rebate of one tenth of the rate for consignments carried under these conditions, this rebate being reserved, be it well understood, to consignments going without breaking load to beyond the land frontier.

This tariff at the same time specifies that such gear is carried free of charge up to a weight equal to one eighth of the rated weight, and also for its return taken apart.

2° *Special wagons (refrigerator, constant-temperature, heated).*

Perishables naturally suffer from being in the wagons if the prolonged stay leaves them exposed too long in summer to the heat which becomes concentrated in the bodies of the wagons, and in winter, to the frost which penetrates those bodies even if all the openings are closed.

Heat is especially to be feared, and for the last few years much ingenuity has been devoted to reducing its effect.

The wagons used for such consignments are more and more constructed with double walls and double roofs, with ventilation by means of louvered openings in the end and side faces.

The wagons are often painted white so as to increase the protection against outside heat.

The use of wagons so constructed is more especially mentioned by the *Belgian State Railway* for the carriage of butter, and by the *Dutch State Railway* for the carriage of cheese, these wagons having shelves with sliding trays as mentioned above.

It is above all developed in France, on the *Paris-Lyons-Mediterranean and the Orleans railways*, and in Italy on the *Italian State Railway*.

Moreover on the latter, which passes through particularly-hot districts, the ventilation is supplemented by special *torpedo* ventilators placed in the roof of the wagons and these make it possible to renew in 100 seconds the air inside the body of a wagon running at a speed of 60 kilometres (37·3 miles) per hour.

On several railways open-work wagons with several decks are used also, for the carriage of milk; finally, there are mentioned some wagons especially intended for the carriage of sea-fish, and some others, however but few, for carrying live fish placed in large tanks, with special machines for circulating and renewing the air.

But for the carriage of these perishables, carriage which continually tends to extend, as we have shown, over greater distances, these different systems are insuffi-

cient palliatives; for there are traffics, such as those in dead poultry and small animals, which practically cannot be carried in ordinary rolling-stock, and where one is compelled, in spite of the great inconveniences which arise, to substitute transports of live animals.

To judge by the experiments carried out everywhere, it is for this reason that the ideas of the railway administrations are becoming more and more concentrated, as far as such longer distances are concerned, up on the use of refrigerator vans. They are, moreover, encouraged in this tendency by the extraordinary results obtained with such special rolling stock in the *United States*, where more than 60,000 of such cars are running, and, nearer home, in *Russia* and *Siberia* where this traffic is quite new but is developing in a very striking manner.

We must, however, guard ourselves against too prompt imitation of those countries :

The *United States*, and *Russia* together with *Siberia* occupy stretches of land which are greater than Europe. The *United States*, more especially, contain a large population very irregularly distributed over regions very different in character, from torrid Florida to the icy lakes on the Canada frontier, from California with a climate particularly suited to the growing of early fruit and vegetables, to New York where very cold winters and very hot summers alternate. Between regions which differ so much, exchange must take place, and owing to the magnitude of the distancees, to the scattered location of the centres of population, the refrigerator car has been and is the necessary and indispensable tool of that exchange.

In Europe, there are similar differences between the climates of different countries, between Naples or Seville and St. Petersburg, between Hyères or Nice and Berlin; but it is essential to note that the United States are inhabited by a homogeneous population, speaking the same language, having the same customs, the same laws; there is nothing, no customs barrier to hinder the circulation of men and goods, while on the contrary Europe is divided into a large number of different countries, where that circulation is obstructed by different languages and different customs, by the variety or absence of regulations, by the customs barriers, and finally by the different gauges in Spain and in Russia.

It is for this reason no doubt that the use of refrigerator vans has as yet only been made the subject of timid experiments limited to short runs inside the different countries, experiments which as a rule have given results but little encouraging. It is for this reason that on the contrary good results are obtained in Russia-Siberia where there are the same favourable conditions of a vast space and a homogeneous people and administration, like in the United States.

Moreover, where these special transports in refrigerator cars are limited to the extent of any one European country, it is evident that they have no great future before them. The comparative shortness of the journeys, the smaller difference and the irregularity in the temperatures, the dispersion of the traffic resulting from

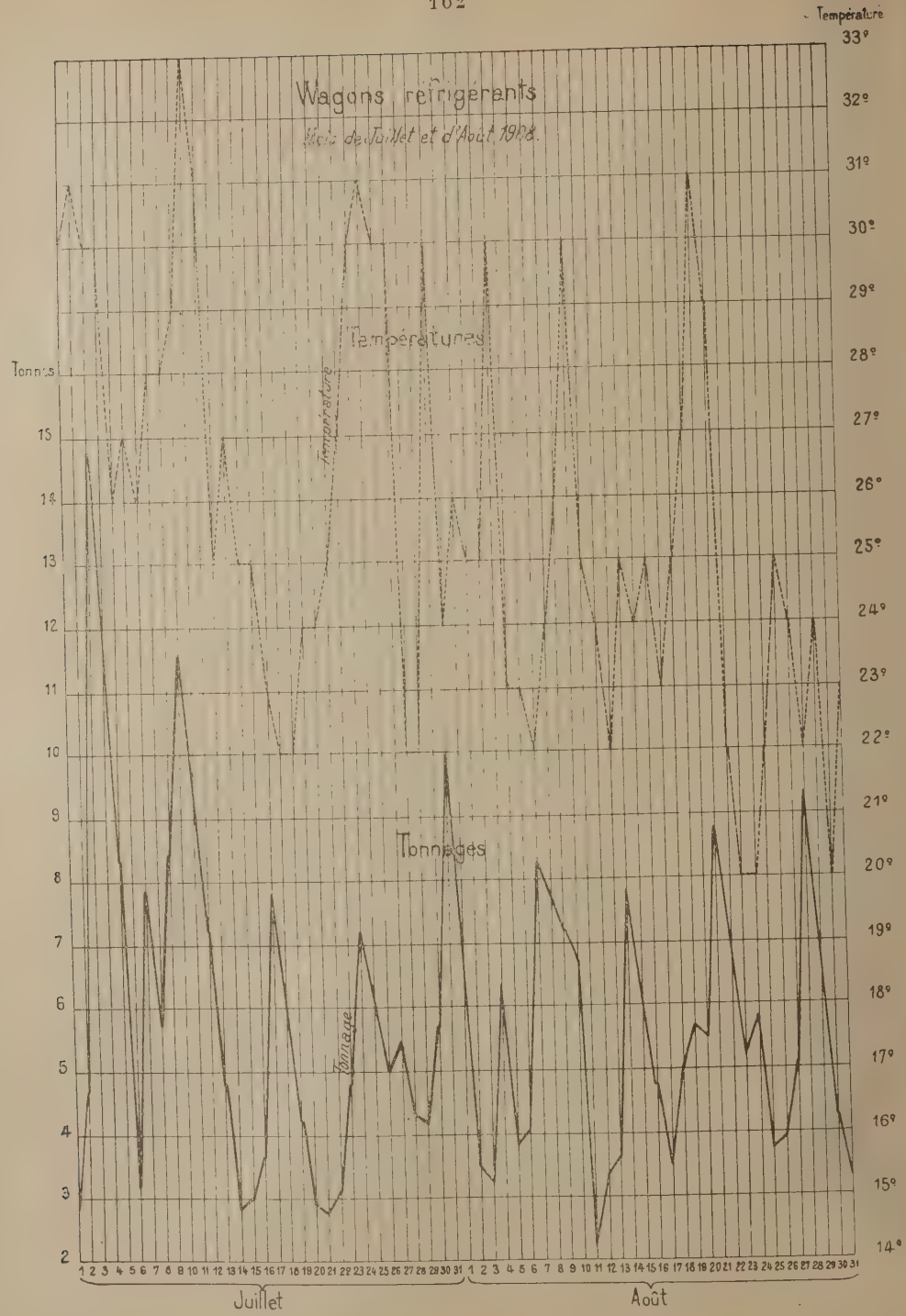

Fig. 21. — Refrigerator van. — July and August 1908.

Explanation of French terms : Température = Temperature. — Tonnages = Tonnage. Juillet = July. — Août = August.

the density of the population, are all causes which must forcibly restrain the growth of this new traffic.

It is in fact evident that trade is but little tempted to incur the expense which the use of such refrigerator vans necessarily involves, for transports which can mostly be effected during the period of one night, and during the coolness of the night. On the other hand a striking instance will show the very great importance of the difficulties arising from the variations in the temperature.

The diagram (fig. 21) shows for the period of 1 July—31 August 1908 the daily variations in the readings of the thermometer at Paris and in the tonnage of the meat brought to the Paris-Orleans station by the daily service of refrigerator vans running to that station.

The nearly-uniform parallelism of the two curves is very significant; it shows that the consignors before handing in their consignments carefully study the thermometer, and according to the results of this consultation choose either the one method or the other, that is to say become resigned or not to the cost of the refrigeration.

It is very evident that daily services can hardly be operated with success, if indeed they can exist, when there is such an irregularity.

This irregularity is moreover also due to the very dispersion of the traffic; the small traders who furnish it can in fact only operate day by day, without considering it to their interest to support a system of transport which is however very advantageous in the hot season.

The results obtained have thus been very mediocre and the tonnage of meat brought in refrigerator vans to the Paris-Orleans station only represents a very small fraction of the total tonnage of that traffic.

In spite of a reduction of 5 per cent in its rates, the French Northern Railway has also had but insignificant results in its carriage of sea-fish from Boulogne to Paris, which is, it is true, but a short distance.

With such results which are approximately reproduced in other countries, it must not be considered surprising if the European railways, Russia excepted, cannot compare with the 60,000 cars of the United States anything except the small stock enumerated in the table below, compiled from the answers received from the different administrations.

RAILWAY.	Refrigerator van belonging to			*Remarks.* *Articles carried.*
	railway.	private owner.	total.	
Alsace-Lorraine	...	12	12	Meat between Holland and Switzerland.
Wurtemberg State	7	...	7	2 milk vans and 5 butter vans.
Baden State.	...	10	10	Vegetable fat.
Prussian State.	113	114	227	63 milk vans, 146 butter vans, 16 fish vans, 2 meat vans.
Oldenburg	...	12	12	Sea-fish.
Bavarian State.	152	...	152	2 butter vans.
Belgian State	20	...	20	Ice and eventually sea-fish.
Austrian State.	156	...	156	Meat, not including 857 beer vans, 781 of which belong to private owners.
Austrian Southern	...	2	2	Fish.
Hungarian State	148	65	213	Meat.
Russian South Eastern . . .	10	...	10	
Moscow-Brest	17	...	17	Heated in winter.
Russian Southern.	27	...	27	19 for fruit, 5 for beer, 2 for dairy produce, 1 for dead poultry.
Moscow-Nijni-Novgorod. . .	18	...	18	Heated in winter.
Transcaucasian	23	....	23	Milk and fruit.
Egyptian State.	One only.	...	...	
Norwegian State.	...	...	...	
Dutch State.	8	...	8	Butter.
Italian State	...	69	69	47 for butter and cheese, 9 for meat, 13 for beer.
French State	13 (1)	17 (2)	30	(1) Butter and meat. (2) Butter.
French companies	...	72	72	Meat, poultry, butter, fruit, sea-fish.
Total (Siberia excluded). . .	712	373	1,085	

This table at once gives rise to the same observation which was already made in the case of the special equipment : namely that the railways chiefly supply those wagons in the countries where they are best protected by the regulations and by the

general discipline of the public against the complaints which must no doubt arise from refusals resulting from the insufficient supply of this special rolling stock.

Moreover, a useful indication is given by this characteristic fact that in the different countries these refrigerator vans are chiefly used for carrying meat, butter, sea-fish, articles which are always being produced, in nearly constant quantities, and which can be more depended on than fruit, vegetables, than irregular and momentary business, to supply the services of refrigerator vans regularly.

The table given above does not include the Siberian rolling stock, because the progress of this special traffic on the railway system of that country is instructive and therefore deserves special mention (1).

It was in 1894, soon after the construction of the Transsiberian, that the export of butter from that country began; but it only assumed special importance when the Russian government wisely decided to help that budding industry by a whole series of measures calculated to promote the establishment of cold-storage depots and by organizing a service of refrigerator vans.

During the last few years, for instance, it authorized the importation, duty free, of about 7,000 tons of articles used for refrigerator plants.

At the same time the government took care to increase its stock of refrigerator vans, which for export butter alone was as follows :

1898. . . .	0	refrigerator vans.	
1899.. . . .	50	—	—
1900. . . .	100	—	—
1901. . . .	370	—	—
1902. . . .	866	—	—
1906. . .	1,050	refrigerator vans.	
1907. . . .	1,292	refrigerator vans out of a total of 1,862 refrigerator vans in Russia.	

In order to supply these vans, a series of ice stores was established along the lines, which increased from 18 in 1898 to 42 in 1900 and 77 in 1907, having a total capacity of 150,621 cubic metres (5,319,419 cubic feet), and so spaced that the distance between any two does not exceed 266 kilometres (165 miles); this maximum is reduced to 170 kilometres (106 miles) on the Transsiberian line and thus enables ice supplies to be obtained twice a day.

This system is supplemented by cold-storage depots at the chief forwarding stations, namely Ob, Kainsk, Omsk, Petropavlovsk and Kourgan; these are intended to receive and store butter pending its despatch.

Finally, there are also cold-storage depots at the chief Baltic ports, constructed either by the State or by private companies, which receive and store butter pending its dispatch by sea.

Without entering into the technical details of the construction of these vans and stores, it is interesting to know that the net cost of the refrigeration by the refrige-

(1) The information which follows has been extracted from the papers submitted by the Russian committees to the International Refrigerator Congress held at Paris in October 1908.

*

rator vans, including all the expenses of the wagons and depots and the interest and amortization of the capital outlay, amounts to 0·81 copeck per pood per day of refrigeration, or 0·91 franc per ton (8·88*d*. per English ton) per day, or 18·10 francs per ton (14*s*. 8·55*d*. per English ton) for the whole journey to the Baltic ports.

This whole scheme planned on such bold lines and carried out very quickly in spite of the disturbance caused by the Russo-Japenese war, has had the very decisive results shown in the following diagram (fig. 22) where curves represent the progress of the export of Siberian butter and also the increase in the number of refrigerator vans.

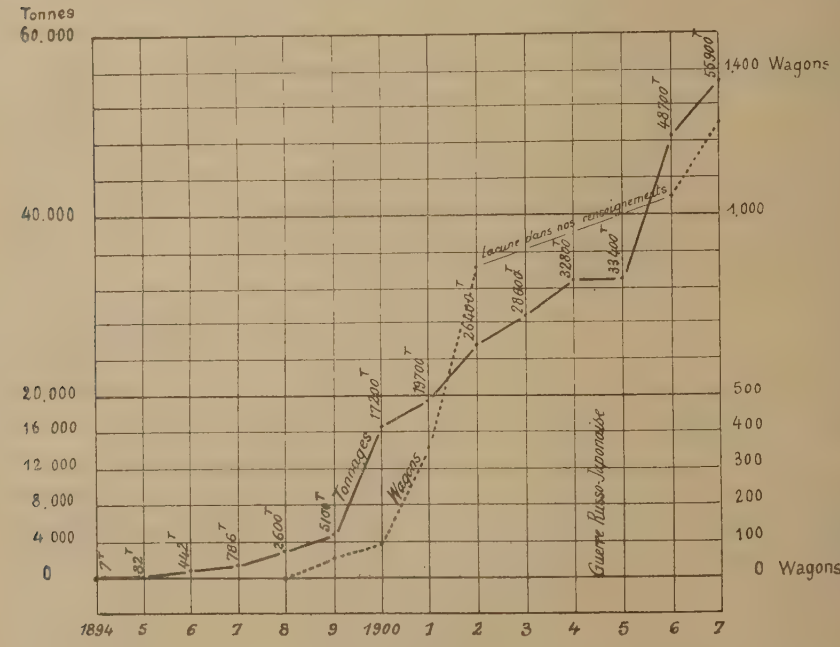

Fig. 22.

Explanation of French terms : Tonnages = Tonnage. — Wagons = Wagons. — Lacune dans nos renseignements = Gap in our information. — Guerre russo-japonaise = Russo-Japanese war.

This result, which does the Russian Administration much honour, gives us a very clear lesson, and that is that for great distances, the use of refrigerator vans is the necessary tool for developing the perishables traffic, is even necessary for its very existence.

If we admit this conclusion and if we recognize the utility of this development in the interests of the well-being of the population and of the railways, it is advisable to investigate all measures possible for facilitating the use of this stock.

In this respect Europe, divided as it is into different nationalities, evidently is not so favourably placed as Russia-Siberia; it seems unlikely that such a result, the organization of similar international services, can be obtained by the disjointed efforts of the different railway administrations.

It is more to be hoped that the future will see the formation of an international company which will be able to effect, for this special traffic, what the International Sleeping Car Company has been able to effect in the case of passenger traffic.

Moreover, it seems rather generally recognized that the supply and operation of these special wagons should not be effected by the railways themselves.

The *Bavarian State Railway*, it is true, expresses the contrary opinion, but with the reserve that on account of the expense it is also advisable to induce the public to provide itself with such stock, and the *Austrian State Railway* has considered it necessary to undertake this service on account of the nature of the meat traffic, *in smaller lots*, which it had to deal with.

On the other hand the *Prussian State*, the *Hungarian State*, the *Transcaucasian* (who own refrigerator vans), the *Italian State*, the *French companies* (on whose lines this particular traffic is also carried in privately-owned stock), have expressed the opinion that the action of private owners is preferable to that of public administrations as regards the selection of suitable rolling stock, the supervision and considerable care necessitated, for instance, by the different temperatures which are most suited to different articles, the quest and retention of a number of agricultural clients who are very scattered and always distrust innovations.

Moreover, from the double point of view of the greater success of private undertakings and the interests of the public itself, a singularly-conclusive experiment is to be found in the simultaneous operation of the two services of refrigerator cars on the French State Railway and on the Orleans Railway; these are operated in two very similar districts on the lines of the two systems, very close to each other, going from Paris to Bordeaux.

Although the official service of the State only demands an extra 10 per cent on the rates while the private company asks for an extra 15 per cent, statistics for July 1907 show that the wagons running on the Orleans Railway line arriving at Paris carried on the average more than twice as much as the wagons of the State line.

Accordingly the railway administrations should not undertake such services themselves, but should limit their activity to the facilitation of the establishment of special companies or even to that of an international company, not only by offering their eventual good-will, but more especially by preparing the field of action by establishing regulations which are uniform and favour the international circulation of these wagons.

Their home regulations at present are very varied; in order at all events to give some idea of the difference and to establish also a basis for any eventual revision, we give in appendix 4 a synoptic comparison of the conditions specified in quick-

freight tariff 121, which has lately come into force for these special wagons after a long investigation of the *French administrations*, of the conditions specified in paragraph 35 of the German tariff, and of the conditions specified in the regulations of 4 April 1908 of the *Italian State Railway*, the two latter applying to all privately-owned wagons.

Unfortunately, this comparison and also the information supplied by the other administrations show that the ground is as yet but ill-prepared for these future refrigerator-van companies.

It is in fact clear that they will not be able to exist except by means of extra rates levied on their customers, over and above the normal railway rates; now nearly everywhere the competition of the railway administrations already makes any such extra rates, and consequently the services themselves, impossible.

In Germany in fact, in Belgium, Hungary, Russia, Norway, the refrigerator-vans which the administrations operate in limited numbers, as an experiment (as the Prussian State says) are placed at the disposal of the public without charging any extra rate. In Austria, the Austrian State Railway only requires the public to supply the ice; in Holland the Dutch State Railway demands an extra rate of 4 francs per ton (3*s*. 3*d*. per English ton); in France, the French State Railway demands a reduced extra rate of 10 per cent; finally in Siberia the extra rate for the entire journey to the Baltic is only 1 kopeck per pood (1*s*. 3·90*d*. per English ton) of butter, while the actual cost is found to be 7·72 kopecks (10*s*. 2·74*d*. per English ton). In all these cases, these extra rates are manifestly lower than the actual cost.

As every service should pay its own way, those concessions cannot be explained *a priori* except by the experimental character which these services seems to have at present nearly everywhere.

No doubt the sacrifices entailed by those modest experiments are of little importance, lost as they are in the general mass of railway operations; but it is just their small magnitude which makes them as a rule useless to the public. They might even be considered injurious, for their mere existence prevents the establishment of private services which could better suit themselves to the varying needs of the different administrations and which seem in fact much better appreciated by the public, as shown in the case of the French State Railway.

In order to clear the future from this point of view and to make possible the establishment and the development of such international services, it seems advisable to withdraw these abnormal favours and ask the public a fair price for this special work.

Or if it seems quite impossible to go back on the existing practice, the railway should deduct from their receipts the sums necessary for properly paying for those particular services, undertaking in place of them the operation of a service which every one recognizes was a particularly-costly one.

But under the existing regulations this solution seems difficultly realizable.

As a general rule, when a railway considers it advisable to accept privately-owned wagons, if these wagons replace its own stock so that it accordingly economizes, it would seem equitable to take this economy into consideration and allow rebates to the owners of these wagons.

Now the *German* regulations contain no proviso to this effect, and the *Italian State* regulations only contain a very uncertain formula.

The *Austrian State Railway* goes even further; it specifies for such wagons a minimum mileage of 5,000 kilometres (3,100 miles) per year on its own system, and charges the owner 2 heller for every kilometre (0·3213*d*. for every mile) less.

Rebates are only found on the following systems :

The *Austrian Southern* grants a rebate of 200 kronen (£8. 6*s*.5*d*.) per wagon per year.

The *Hungarian State* according to the Austrian State allows a rebate to the wagons which can generally be utilized, of 1·8 heller per kilometre (0·2892*d*. per mile), whether loaded or empty, when the annual mileage is between 10,000 and 20,000 kilometres (between 6,200 and 12,400 miles).

Finally there are the *French administrations* which in the case of refrigerator-vans allow a rebate of 0·02 franc per kilometre (0·3090*d*. per mile), whether loaded or returned empty, on the quick-freight rates; this rebate is provisionally increased to 0.045 franc (0·6952*d*.) on the Orleans Railway.

Limiting ourselves to these two most important points and not extending the analysis to other questions of detail, we see that the desired agreement will not be reached without difficulty. It is however indispensable, and should, we think, be aimed at in the directions mentioned, if any appreciable result is to be arrived at and any advance made on a road which may perhaps be prolific of new traffic.

From this point of view finally, it seems necessary to draw the whole attention of the administrations interested to the measures to be taken for facilitating the transit of these wagons at the two frontiers, Russia and Spain, where the break of gauge creates a special and a serious difficulty.

Already systems involving the change of the axles of vehicles have made it possible for a number of slow-freight wagons to cross the Russian frontier without being unloaded; royal orders have just been issued authorizing the application of these systems at the French-Spanish stations of Irun and Cerbère. It is to be hoped that with the active co-operation of the railway administrations concerned these applications will soon be extended to the transit of quick-freight perishables wagons and especially to that of refrigerator-vans.

CHAPTER V.

Claims.

At the commencement of chapter II, dealing with tariffs, we explained in a general way the situations and the ideas which in the different countries had guided the railway administrations in the establishment of their tariffs, and we mentioned among other matters the profound differences which exist in their manner of looking at the responsibility of the railways to the public.

In the case of the perishables traffic, these differences affect above all the question of delays, the most important question affecting this traffic. As regards the other causes of claims, loss and damage, there is much the same protection everywhere against the complaints of the trade and of the public, but we think that from this point of view the different countries can be divided into two distinct groups.

Firstly there are those, generally the countries with strong administration, where the railway systems are principally operated by the State which is therefore interested in protecting their receipts; secondly there are those, principally the Latin countries, where the bulk of the railways are still in the hands of private companies which are consequently less well protected or defended by the State, and which in addition have to reckon with public opinion and tribunals less imbued by the sentiment of the general interest.

Thus we see the restrictive rules of the Berne International Convention reproduced without any alteration or even with aggravations in the home regulations of Germany and Austria-Hungary, notably article 31 of the International Convention referring to damage which becomes paragraph 77 of the German regulations; in France and in Spain however, not only have the rules of the International Convention not been admitted into the home regulations, but these have been added to since : in France by the act of March 1905 which has modified article 103 of the commercial code so that in all cases of damage the presumption of fault falls on the carrier; in Spain by the new commercial code and by recent Royal orders.

The differences between the state of opinion in these different countries can be well shown by quotations from some of the answers sent to our list of questions; thus according to the *Bavarian State Railway*,

the text of paragraph 77 of the German regulations (which agrees with article 31 of the Berne International Convention) is sufficiently flexible to make it possible to reject any exaggerated claims. It states :

> The attempts of commerce to have this paragraph 77 struck out have remained without result up till now, and also will very probably remain without result in the future; for the railway, unless it wants at the same time to raise its tariffs materially, cannot be responsible for damages the source of which is inherent in the very nature of things.

The *Hungarian State Railway* states that in cases of delay the consignors have a tendency to extend the liability of the railways to the damage to the goods; but the claims made in the courts have not been admitted, the tribunals upholding as regards damage to the goods the text of the Berne International Convention (article 31 states that the railways are not liable except in case of serious negligence).

In *Russia*, the general regulation of the Russian railways go so far as to provide for the eventual intervention of the police in the proofs to be produced by the public in support of claims in cases of loss.

According to the *Russian Southern*, the question of limiting the responsibility of railways is on the agenda of the general meeting of the representatives of the Russian railways.

In *Norway* it is specified, with quite an extraordinary profusion of restrictions, that the State Railway is in no way liable unless it can be " proved *without any possible doubt* that the damage or *loss* is *exclusively* due to an *evident* fault or negligence of the railway employees ".

In *Switzerland*, in special tariff No. 4, which concerns the application of the *luggage* system to the carriage of certain perishables, in exceptional tariff making it possible to use all trains, except the through trains, for milk, the railways have inserted clauses which formally limit their liability in cases of delay to the observance, pure and simple, of the ordinary times allowed for *slow-freight*.

In *Belgium*, we find in the general rules for applying the tariffs an article 27, which runs as follows :

The administrations are responsible neither for *loss* nor for *damage*, nor for the *risks* to which are exposed, during conveyance :

1° . . . . . .
2° . . . . . .
3° . . . . . .
4° . . . . . .
5° Goods which are liable to damage from their very nature or from the mere fact of their carriage, such as. . . fresh meat, fresh fish, eggs, fresh fruit and vegetables.

In *Italy*, article 129 of the general conditions releases the railways from all liability for damage and depreciation of goods which are carried at owner's risk and peril. Now this is generally the case with perishables, and slow-freight tariff A No. 55 for such exports contains, for instance, the following clause which has already been referred to :

10° The consignments favoured by this special tariff are accepted and carried at the risk and peril of the consignor, who can claim no compensation from the railway administration for deterioration, damage, natural waste of the goods, unless he can prove that this results from the neglect of the administration.

As opposed to these very peremptory rules and regulations, we find the following information in the answers received from Spain and France :

The *Spanish Northern* mentions the tendency to increase the responsibility, a tendency which has shown itself in the new commercial code and in the Royal orders (referred to above) and in a conference held at Madrid in 1905 and summoned by the government at the request of the chambers of commerce and the industrial syndicates.

In *France*, we have already dwelt upon the tendencies of the extraparliamentary commission which met in 1905 to consider the question of the perishables traffic.

We have already previously referred to the act of March 1905.

The French companies in their answer mention nearly unanimously the tendency there is to increase their responsibilities.

For instance, the *French Northern* states that it manifests itself by new laws, by numerous judgments which are unfavourable to the carrier (1), by the continually-increasing demands of the trade and of the public.

The *Paris-Lyons-Mediterranean* mentions the same tendency of commerce and of the tribunals, to extend the responsibility.

According to the *Midi Railway*, the compensation is now increased by comparatively large " profits missed ".

The " *laissé pour compte* " which are always so burdensome, and with regard to which the tribunals of commerce are generally very strict, become more numerous.

The jurisprudence of the tribunals of commerce tends to increase the responsibility of the railways.

On the *Orleans Railway* the situation is similar.

Moreover, it is everywhere observed that the act of March 1905, by taking away from the railways nearly all their means of defence, has had the effect of promoting the establishment of a large number of agencies who have undertaken the special business of claims against railways and exploit with the greatest activity every incident, even the smallest importance, which can serve as a pretext for a claim or an action-at-law.

Now that we have elucidated the state of the question in different countries, it is advisable to consider these difficulties in detail, in order to seek in the answers, often very summary, sent by the different administrations, the points which are of special interest.

We will adopt the following order in our review : loss, delay, damage (and especially waste).

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(1) The decisions of the Tribunal of Commerce, when only on matters of fact and without raising a point of law, cannot be appealed against unless the sums concerned exceed 1,500 francs (£60), a sum which much exceeds that involved in most of the suits brought before this tribunal.

Loss.

The *administrations of Central Europe* apply article 34 of the International Convention (paragraph 80 of the German regulations), according to which the compensation given in case of loss only represents the value of the goods at their starting point, and then also limited by the tariff applied.

Nothing is allowed beyond that amount unless there is a special declaration of interest in the delivery, which has to be paid for.

This rule of the payment of the absolute value of the goods is also found in the *Russian* regulations, in the *Dutch* regulations which limit this value to a maximum of 0·60 florin per kilogram (5·43*d*. per lb.) gross, in the *Norwegian* regulations which, as we have already stated, go to the length of only granting compensation in case of *evident* negligence on the part of the railway.

In *Italy*, we find the peculiarity that goods carried under the *general tariff* have compensation paid on the basis of the price at *destination*, while in the case of the special tariff only the price at the *starting* point is taken into consideration, which is naturally lower.

As opposed to this system which obtains in countries with State railways, we find *in France* that the tribunals show a tendency to make allowances, sometimes very considerable ones, for " profits missed ", even in cases where the immediate replacement of the goods accordingly makes it possible to double the profit. As this facility encourages traders, such replacement tends more and more to take place, even in cases of the shortest delays which are then followed by very onerous charges.

Delays.

It is in this case, above all, that the practice in different countries varies very much; it is however essential to observe that the much stricter rules of the French railways have not been imposed on them, but that they have been accepted and even proposed by them with the object of safeguarding, by efficient guarantees, the exceptional measures taken in connexion with the train services and the station services in the case of the perishables traffic; the railways proposed, by these guarantees, to give new and serious encouragement to the development of this traffic.

We will give details of the rules in force in the different countries, referring to the times allowed for the transport, limiting ourselves to the cases of Germany, Italy and France.

In *Germany* the following times are laid down in paragraph 63 of the traffic regulations.

a) Quick freight:

1. Time for service operations	1 day.
2. Time for conveyance per indivisible fraction of 300 kilometres (186 miles) . .	1 —

b) Slow freight :

1. Time for service operations		2 days.
2. Time for conveyance	up to 100 kilometres (62 miles)	1 day.
	beyond and for each section of 200 kilometres (124 miles) more, even if only begun	1 —

We would also recall that as the slow-freight tariffs are in fact applied to a large proportion of the perishables traffic, it is the latter time which has to be considered, together with all the supplementary restrictions which the regulations impose on this traffic.

In *Italy*, the accelerated slow-freight tariffs which are applied to perishables, contain the following conditions :

Accelerated slow-freight tariff 50, for home traffic :

Twenty-four hours for every 225 kilometres (140 miles) of distance; plus eighteen hours for service operations, and six hours for transit between lines under different administrations.

The counted time begins at the start of the first train, after the loaded wagon has been handed in, provided this has been done at least one hour before that start.

The accelerated slow-freight tariff 55 for export traffic applies, as we have already stated, the times of the International Convention, but reducing the distance on Italian lines by 30 per cent.

In *France*, as the text quoted in chapter II shows, the rules fixed by the new tariff include essentially the obligation of the railway to deliver the goods within the two hours fixed by article 54 of the general conditions of application of the quick-freight tariffs, those two hours being reckoned from the booked time of arrival of the train which has in fact conveyed the goods.

Let us compare the results of these different formulæ, taking as an instance a consignment of fruit handed in 1 September, 2 p. m., at the Montauban station to be conveyed to Paris, distance 662 kilometres (411 miles), conveyed by train 6016 starting at 3·5 p. m.

German formula :

1° Application of quick-freight tariff :

The legal time allowed would begin 1 September at midnight and would finish 5 September at midnight.

Total time after handing in the goods . . . . . *106 hours.*

2° Application (ordinary) of slow-freight tariff :

The time would expire 7 September at midnight.

Total time after handing in the goods . . . . . *154 hours.*

With a consignment similarly handed in on Monday 30 August, as the time would expire Sunday night, it would accordingly have twenty-four hours more to run, bringing the total to . . . . . *178 hours.*

Italian formula :

The first train starting being train 6016 at 3·5 p. m., the time starts then and finishes three days eighteen hours later, *i. e.*, at 9·05 a. m. on 5 September.

Total time after handing in the goods . . . . . *91 hours 5 minutes.*

French formula :

Train 6016 is continued from Aubrais on by train 6020 due at Paris at 5·01 a. m. the legal time finishes at 7·01 a. m. on 2 September.

Total time after handing in the goods . . . . . *17 hours 1 minute.*

These examples show that the German and Italian railways, and with them most of the foreign railways, have in fact not to consider this question of delay much.

Be this as it may, the almost-universal rule if the legal time allowed is exceeded, and in the absence of any special declaration of interest in the delivery (which is paid for), is to allow the parties concerned compensation equal to a given fraction of the rate, a fraction naturally increasing with the importance of the delay.

We know the formula of the International Convention which, in the absence of any declaration of interest in the delivery, fixes the compensation at as many tenths of the rate, up to a maximum of $^{5}/_{10}$, as there are tenths of the legal time allowed in the delay.

Paragraph 87 of the German regulations contains a stricter rule with regard to the public.

Counting only delays of more than twelve hours, it fixes the rate of compensation at $^{1}/_{10}$ of the cost of carriage for every whole day of delay up to a maximum of $^{5}/_{10}$ if there is no proof of losses incurred, and up to the whole amounts if such proof is given. In agreement with article 33 of the International Convention, paragraph 79 of the German regulations states, moreover, that the goods may be presumed lost if the delay exceeds thirty days.

In *Russia*, the compensation is calculated at $^{1}/_{20}$ of the rate for each day of delay, up to the total amount of that rate.

Perishables are moreover considered lost and their value can be claimed when the delay exceeds from two to fifteen days, according to the nature of the goods.

Article 25 of the *Belgian* regulations specifies a compensation of $^{1}/_{15}$ of the rate per day of delay, and the consignment may be presumed lost after a delay of fifteen days.

In *Italy*, article 7 of the general conditions for the application of the special tariffs specifies that if the delay is not longer than twice the legal time allowed for the conveyance, the railway can only be held liable for a reduction in the cost of carriage, in accordance with the importance of the delay.

In *France*, the compensation in cases of delay is also reckoned in fractions of the cost of carriage, but the calculation is based on the *hours* of delay instead of the *days*, and it is when the delay exceeds twelve hours that the consignors or the consignees can already claim the profit under common law.

However, as regards the quantity of these compensations for delay the French regulations, as compared with the regulations of the other countries or with those of the Berne International Convention, show an important difference which has to be mentioned.

Actually, these compensations are very frequently granted even if no losses have been incurred, and thus assume the character of a contract, instead of the French tariffs making their payment on the contrary conditional on the proof of a loss incurred.

Finally, encroaching of the subject of damage which we will consider in our next section, we must here say a few words about damage which may be caused by delay, such as for instance over-ripeness.

In the case of such delays, the public has in fact a tendency to urge its claims from this point of view of damage so as to escape the limitations of compensation which result from the special clauses referring to the exceeding of the legal times allowed.

The difficulties raised in this connexion in Hungary have been done away with by the tribunals by virtue of the limitations of the International Convention.

The question appears undecided in Italy.

The French railways have eliminated this source of dispute by inserting in their regulations a precautionary clause which runs as follows :

Condition of the goods. — *The perishables must be despatched in such a condition that they can stand an extra period of twelve hours without deterioration from excess of ripeness or of age.*

Damage.

As a general rule, the questions of compensation for damage are treated in the different countries according to the same principles as in the cases of loss.

The regulations accordingly take generally as basis the absolute value of the goods in accordance with the rules of the International Convention (art. 34) or of similar regulations, such as the German regulations (§ 80); while in France damages plus interest are but too frequently added.

The home regulations of *Germany* (§ 77) moreover repeat the presumption of freedom from liability, which forms the object of article 31 of the International Convention.

We have seen the strict limitations of the *Belgian*, *Norwegian*, and other regulations.

Going further afield, we find that the *Russian* regulations specifically release the

railway from all liability for interior or hidden damage (which can in fact be as much caused by the consignor as by the carrier).

In accordance with article 34 of the International Convention, paragraph 81 of the *German* regulations specifies the establishment of special tariffs which contain, in exchange for more reduced rates, stipulations concerning the maximum compensation to be paid in cases of loss or damage.

Article 130 of the *Italian* regulations provides also for the case of similar special tariffs releasing the railway from all liability unless negligence is proved, etc.

Now all these clauses of absence of liability or of presumption of absence of liability have on the contrary been eliminated from the *French* tariffs by the act of March 1905; in cases of damage the railway now finds itself charged with the presumption of negligence, with the additional difficulty that it most frequently actually finds it impossible, at the forwarding stations, to make all those examinations of the packages which would be necessary for determining the condition of the goods inside.

In the case of perishables which are often consigned in a damp condition and liable to lose weight by the action of the atmospheric influences, it is rational and moreover usual to allow for normal *waste*; the same applies to such articles as eggs which not only cannot be carried without a certain number of breakages occurring, but which are often handed in at the forwarding stations without any practically-possible verification of the damage which may already be present inside, and often actually is present and caused by defective packing or by conveyance to the station on carts without springs or passing over bad country roads.

As regards this question of waste, the rules applying in the different countries vary considerably and often seem very uncertain.

Paragraph 8 of the executory provisions which supplement article 32 of the International Convention and are reproduced in paragraph 78 of the German regulations, include more particularly an allowance for waste amounting to 2 per cent in the case of fresh fruit and to 1 per cent in that of dry goods liable to waste.

But as the *Baden State Railway* informs us, this rule is rarely applied, owing to the great diversity of the circumstances. Thus for instance, the *Prussian State Railway* indicates for eggs a rate of 8 1/3 per cent (1), accepted without trouble by the German traders both for home as well as for international traffic.

According to the *Hungarian State Railway*, in the case of consignments of small live animals, the rate of the waste depends on the conditions of food, drink and health of these animals while on the way, and it is impossible to fix any definite rule.

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(1) A decision of the Supreme Court of the German Empire (10 October 1906) has quashed a judgment of the Court of Appeal which, not taking into account article 31 of the International Convention, has limited the waste by breakage to 1 per cent (*Bulletin des transports internationaux*, May 1907, p. 188).

In *Russia*, the regulation rate is 2 per cent for fruit, vegetables, eggs, butter; 1 per cent for game, fish, flowers, meat, cheese and dead poultry.

In *Holland* as a rule, a maximum of 2 per cent is allowed per package.

In *Spain*, the rates of waste have been fixed by a Royal ordinance; for instance the *Andalusian Railway* names the following rates :

Vegetables and fruit	5	per cent	in summer	4	per cent	in winter.
Fish carried without ice. . . .	6	—	—	5	—	—
— in ice	12	—	—	8	—	—

The Spanish Northern gives the following :

Eggs : 6 per cent up to 200 kilometres (124 miles) and 2 per cent for every additional 100 kilometres (62 miles), with a maximum of 9 per cent in summer and 7 per cent in winter (1) ;

Butter, fat, poultry, small animals : 2 per cent up to 200 kilometres (124 miles) and 2 per cent for every additional 100 kilometres (62 miles) ; with maximums of 5 per cent in summer and of 4 per cent in winter, in the case of butter and fat; and with maximums of 8 per cent in summer and of 6 per cent in winter in the case of poultry and small animals.

In *Italy*, the question is at present being investigated and it is announced that official tables of these allowances will shortly be published.

At present no such table exists except in special quick-freight tariff No. 3, for the conveyance of perishables as quick freight.

This table fixes among other things the following allowances for waste for every period of twenty four hours and for every 100 kilometres (62 miles) of journey :

Plucked dead poultry in small packages of the following weights :

Up to 50 kilograms (110 lb.).	6 per cent.
— 100 — (220 —).	4 —

LIVE BIRDS.	In truck-loads.	In broken loads subject to transhipment.
1. Turkeys, geese, ducks	10 p. c.	15 p. c.
2. Fowls, chickens, capons	8 —	10 —
3. Pigeons	10 —	15 —

In *France*, there is neither any official rule, nor any generally-recognized table.

Traders have even contested the legality of these allowances for waste, on the

(1) In consequence of the complaints raised against these rates by the traders, experiments will be made to check their correctness.

pretext of the increases in the rates, now abandoned, which had in 1905 been granted to the railways, as compensation for the elimination of the clauses of absence of liability in their tariffs.

However this may be, the following are examples of rates which appear accepted by the ordinary legal practice of the tribunals or by the opinions of the chambers of commerce.

Eggs : 3 per cent (5 per cent for those from abroad) (1);

Live poultry (according to a decision of the Bordeaux Tribunal) : 0·275 per cent per hour from the time of consignment to the time of delivery;

Apples and pears : 2 to 4 per cent according to distance;

Fat : 4 per cent in winter, 5 per cent in summer (French Northern Railway);

Fat and butter : 0·5 per cent up to 200 kilometres (124 miles), 1 per cent for every additional 100 kilometres (62 miles), with maximums of 4 per cent in summer and 3 per cent in winter;

Fish carried in ice : 8 to 30 per cent of the total weight.

All these examples show us definitely that the determination of the rate of waste is made a little arbitrarily in the different countries and even by the different administrations; in any case, the summary rule contained in article 32 of the International Convention and paragraph 8 of the executory provisions is quite insufficient, and no longer meets, even distantly, the needs of an international traffic which is continually becoming more and more important.

It would seem useful to proceed to the establishment of a well co-ordinated list, taking into account the nature of the goods and the consignments (truck-loads or broken loads), also allowing for the distance as in some Italian, Spanish and French formulæ, and for the time required for the journey, as in the formula of the Italian quick-freight tariff No. 3.

Such a table would serve as a guide and support to the railway administrations without however preventing them from investigating and discussing special circumstances eventually leading to coefficients higher than those minima.

CHAPTER VI.

Various measures. — Packing, etc.

Perishables have to fear delays more than ordinary goods; damages can take away their whole value, thefts may result from the temptation they exercise.

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(1) Leaving out of consideration all the circumstances arising in the case of a traffic in eggs, the Tribunal of Commerce of the Seine has just refused (18 March 1909) to allow for any waste.

Hence, railway administrations are generally induced to surround this traffic with special safeguards, to exercise more careful supervision; they also strive to induce the consignors to take more care in packing and labelling.

1° Measures taken by the railways themselves.

The answers made by the different administrations to this particular question chiefly consist in references to their General Instructions, instructions which hardly ever distinguish between the different kinds of goods, and on the contrary give general recommendations, the exact application of which would no doubt suffice to ensure safe conveyance for the perishables.

Some of them have however thought it advisable to insist upon these recommendations or to add sundry supplementary prescriptions, and we will reproduce information collected in this connection from the answers given or from the instructions annexed to these answers.

Labelling. — *On packages :* that eggs are easily broken is a fact which appears to have been generally considered, for nearly all the administrations put on these packages labels bearing the word " eggs " in large characters, some adding special recommendations such as " fragile ", " this side up ", " with care ", etc.

In order to facilitate the delivery of fruit and vegetables at the Paris markets, the *Orleans Railways* place, in addition to the ordinary label, a special yellow label on all packages forming one and the same consignment; this label bears an order or reference number which is accordingly repeated on all the packages, and one of these labels is stuck on the documents handed to the consignee.

These special labels which are supplied by the railway are moreover often stuck on by the consignors themselves in order to accelerate the departure of their consignments.

The consignments sent to England from the Orleans and the Paris-Lyons-Mediterranean railways have different labels stuck on them, according to whether they go through to London or to places beyond, or to Boulogne or Calais to be sent on from those ports.

On wagons : in order to ensure their quick circulation a large number of administrations prescribe special labels, at least for the principal routes of the traffic. In Germany for instance, placards are often put stating the nature of the contents of the wagon.

The normal labels also have entered on them a list of the successive trains to be used to the destination station.

The *Austrian State Railway* has adopted labels of special and very striking colours for the wagons containing perishables coming from Trieste, the same colour being used for the papers in connection with this special traffic.

Besides the placards stating the nature of the contents, the *Hungarian State*

Railway also adds other special ones with the announcement " Perishables " in three languages : Hungarian, German and French.

In France, on the *Orleans* and *Paris-Lyons-Mediterranean* systems, there are placed on the wagons loaded with perishables for England a certain number of the special labels which are stuck, as we have mentioned above, on the packages which are loaded in these wagons.

Finally as regards eggs, in addition to the labels " eggs " placed both on the wagon and on the packages, other labels are added by many of the administrations, intended more especially to draw the attention of shunting yards to these wagons.

Documents. — In a preceding chapter we have mentioned the useful precaution, taken by the *Italian State Railway*, of placing duplicates of the documents in the wagons.

At Paris, where exchanges between the Orleans Railway and the French Northern make these documents pass through the hands of a certain number of employees, it has only been found possible to regularize their transfer by instituting a special supervision.

The Orleans Railway has moreover obtained good results in a general way by a measure as follows : at each of the important seasons of fruit traffic or early-vegetables traffic, a special official is appointed to watch over all the details of the service in the district concerned, so that he can at once deal with any difficulties which turn up, or can send along the advices necessary.

Miscellaneous measures.

Very generally the different administrations try to meet the temporary needs of the early-vegetables season, the fruit season, the oyster season, etc., by increasing the staff, the appliances, the weighing apparatus, etc.

The only items in the answers sent us, to which we would draw attention are :

The *Midi Railway* uses at the stations on the line between Lamotte and Arcachon, special frames placed on carriages and sliding on the rails.

The *Orleans Railway* puts up light temporary sheds at the stations from which the fruit is despatched.

2° Measures demanded from the public.

Labelling the packages. — The work at the forwarding stations would naturally be much facilitated and rendered more certain by obtaining from the consignors full addresses giving the name and address of the consignee together with the *name of the destination station generally used.*

But here we meet with a very serious difficulty arising from the fact that this

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business of perishables, as we have already explained, often depends on personal relations, laboriously established between the consignors and the consignees; competitors naturally try to penetrate the secrets, jealously hidden, of these relations; and if full addresses were given, nothing would be easier than for them to do so by simply walking about on the platforms of the stations when these packages are about.

It is for this reason that there has always been the strongest opposition, in our opinion very naturally, to the demands of the railway administrations for proper and complete addresses.

The regulations of most of the administrations accordingly limit themselves to the demand that the labels shall bear the name of the destination station, as well as the number and mark inscribed on the way-bill.

In this connection we find an interesting and very significant proviso in article 2 of the regulation of the *Belgian* State Railway.

This in fact directs the consignors of certain packages weighing less than 60 kilograms (132 lb.) to place on these packages a complete address; but this may be limited to a mark and to the name of the destination station if the consignor hands the forwarding station, together with the way-bill, a separate label giving his address and that of the consignor and also the mark on the package.

In *Spain*, the *Spanish Northern Railway* requires the consignors to attach firmly strong parchment or wooden labels to sacks or baskets containing goods. In the case of consignments going abroad, the labels must bear the name of the consignee.

This latter prescription, which is contrary to the usual practice, is also to be found in *France* in the accelerated slow-freight tariff of the Western Railway and in the common accelerated slow-freight tariff No. 103 of the Western and Orleans Railways for the Brittany sea-fish traffic; but at least as regards the latter traffic, it has been found impossible to compel the consignors to apply it.

In their new quick-freight tariffs, the French administrations have again returned to this question, but authorizing the consignors to hide the name of the consignee under a fold of the label, which is of a pattern now extensively used, and the use of which for broken loads conciliates all the interests; it can therefore, we think, be recommended.

We moreover reproduce the conditions of these new tariffs, which bear on the labelling of the packages by the consignors, drawing attention to the option left to the administration (which they are going to utilize) to require different colours, according to the destinations.

The consignor must place on each package or case a label at least 10 centimetres (4 inches) long and 5 centimetres (2 inches) wide, fixed in a manner that it cannot come off on the way. The use of adhesive material is specially prohibited in the case of packages containing sea-fish.

These labels must bear on them, either openly or hidden under a fold, the name and

address of the consignee; they must also reproduce in a very exact and a very legible fashion the marks inscribed on the way-bill, and also, in large letters, the name of the destination station and of the railway it is on.

The administrations reserve themselves the right of requiring the consignor to use labels of different colours, fixed by them according to the destinations or groups of destinations.

These are rather detailed prescriptions and yet experience shows that in order to avoid difficulties with the consignors it would still have been advisable to enter more into matters of detail and to supplement them by adding a definition of the materials the attached labels are to be made of : parchment, wood, metal, etc.; while paper and card should be excluded; by specifying that several tacks should be used, and not only one, for the fixed labels, etc.

Finally, we think it useful to mention the attempts made by the administration of the *French State Railway* to induce consignors of perishables, particularly of sea-fish, to place inside the package a duplicate of the address so that if the outer label disappears the package can still be dealt with.

Packing. — The packing of perishables has to fulfil several functions.

It must be constructed and closed in such a way as to prevent any theft of these goods, which are more exposed to this than any others.

It must be strong and well arranged inside, so as to protect these delicate goods from damage.

It must have a good appearance outside and be well arranged inside, so that the goods may show up well for purposes of sale.

The first point of view of possible theft naturally receives special attention from the administrations, particularly in the cases of consignments of live poultry, meat, eggs, etc.

Alsace-Lorraine, *Prussia* and no doubt all *the other German administrations* specify in an absolute manner that consignments of meat, when not packed in cases or in barrels, must be in packages which are corded and sealed or lead-sealed in such a way that theft without breaking the seals or lead seals is impossible.

The *Italian State* specifies that the coops or baskets containing poultry or small animals, live or dead, must be covered externally with a net, which is continuous and not pieced together, the meshes not exceeding 2 centimetres ($^{13}/_{16}$ inch) in size; this net must be secured by the seals or lead seals of the consignor in such a way that it is impossible to tamper with it.

In *France the Midi Railway*, instead of these formal prescriptions, insists that the consignors of live poultry shall secure the openings of the coops by means of lead seals, and recommends them to cover the coops with iron wire work.

It demands, and so does the *Orleans Railway* also, that meat should be wrapped

in canvas and sown up with string, which must be in one continuous piece and have its two ends lead-sealed.

The same demand is made in the case of game.

The *Paris-Lyons-Mediterranean* is desirous that in the case of live poultry and small animals the bars of the cages should be sufficiently close together to prevent the animals from putting out their heads.

But all these demands clash with the tendency of the consignors to reduce the cost, that is to say the strength and consequently the security of their packages, a tendency which is now increased by the new law which presumes the responsibility of the railways in all cases and makes it a difficulty for them to resist any claims, however ill founded.

It thus appears necessary, and this is true very generally, not to limit oneself to these attempts, to these recommendations, but to profit by all circumstances, in particular by all reductions in the tariffs to introduce clauses of this kind which would thus become obligatory into the conditions of the latter.

The following clause in the new French quick-freight tariffs still seems too general and too vague from this point of view, except perhaps as regards the packing of meat :

> The packages must be packed in a way which corresponds to the duration of the conveyance and which protects the contents sufficiently well to make it impossible to tamper with them without leaving marks. The canvas in which meat is packed should, more particularly, be sewn up.

As regards *the strength of the packing*, the answers of the administrations deal more particularly with the traffic in eggs, which among the perishables are in fact those which break most readily.

Some *require* the consignors to use proper packing.

For instance the *Hungarian State Railway* specifies a case or barrel made of wood without defects; the spaces between boards must not exceed 3 centimetres ($1\ ^3/_{16}$ inches), it must be hooped at the two ends and at the middle with 3 hoop-wood or with iron-wire plait, 4 to 5 centimetres ($1\ ^9/_{16}$ to 2 inches) wide, nailed to the wood so as to make tampering impossible.

On the other hand other administrations must limit themselves, with doubtful results, to attempting to induce their customers to take certain measures; thus the *French Western* recommends the exclusive use of wooden cases, the *Paris-Lyons-Mediterranean* recommends that the boxes should have handles fixed to them to facilitate their manipulation, and the *French Northern* recommends in a general way that good packing should be used.

Here again, and particularly in France since the act of March 1905, it would be best to have definite and obligatory rules inserted in the tariffs : the *Orleans Railway* has recently recognized this necessity and taken advantage of the establishment of a seasonal tariff to insert in it the following conditions :

External arrangement. — The eggs are packed in cases weighing not more than 110 kilograms (242·5 lb.) each. Cases weighing more than 80 kilograms (176·4 lb.) are divided into two compartments by a cross-partition made of boards.

The walls of the cases may be solid or latticed; the openings must then be smaller than the smallest dimension of the eggs. They must moreover be made of boards not less than 0·015 metre ($^9/_{16}$ inch) thick, firmly nailed to battens at the corners, and must have no projections on the bottom; the small ends must have handles or slots to facilitate the manipulation.

Internal arrangement. — The bottom and the side walls must be lined inside with a thick layer of long straw, not broken; the eggs carefully arranged by layers, of the thickness of an egg. Between each layer of eggs there is a layer of crushed or broken straw of the same thickness. A final layer of long straw is placed on the top in such a way that the cover gives the pressure necessary for keeping the whole in position without crushing the eggs.

Except as regards the thickness of the wood, in regard to which the railway allows some latitude, these conditions have been accepted and are applied without difficulty by the public.

These prescriptions are moreover found, although less detailed, in the rules recently laid down for the construction of egg boxes by the *Kiev District Committe* which in order to obtain a better guarantee against deterioration and theft has decided that in future these boxes are to be constructed of definite size, of strong material at least one inch thick, and that in addition they must have round them hoop-iron or iron wire with the ends lead-sealed.

The frequent thefts which often took place from boxes simply nailed down show that this last precaution, of adding hoop iron or iron wire, already specified on other railways, is far from being useless.

When these conditions, which may be demanded, are not satisfied by the consignors, the usual rule is to make them sign on the way-bill an acknowledgement of the bad or defective state of the packing. These acknowledgements are utilized in case of any difficulties as regards loss or damage.

The *Prussian State* also mentions that in Germany a duplicate of this acknowledgement must in that case be handed to the forwarding station.

On the *Belgian State Railway*, article 2 specifies that this acknowledgement can be demanded from the consignor if the package is in such a condition that it can be rummaged in without breaking it open.

The third condition concerning *the arrangement of the articles inside the package* does not really concern the railways.

It is however not omitted in the recommendations, notices and propaganda, more especially, of the *French railways.*

A large number of administrations moreover take steps to induce the consignors to improve their packing.

The *Prussian State* at the beginning of every season reminds them of its previous recommendations and at the same time requests them to make all efforts to carry out the loading and service operations quickly.

The *Hungarian State* mentions the taking of similar steps.

The *Italian State Railway* goes still further in this direction and joins other parties in giving prizes for the best patterns of packing.

An interesting system is also mentioned in which the Italian State Railway may participate; it consists in placing in the packages of fruit going long distances reference checks according to which those packers whose packages arrive in best condition get prizes.

In *France*, the intervention of the railways, particularly of the *Paris-Lyons-Mediterranean* and the *Orleans*, is very active, and effectively seconds the propaganda of the officials of the Minister of Agriculture and of the agricultural associations.

Pamphlets with photographs of the best systems of packing are extensively distributed, special exhibitions are held, at which lectures are often delivered, at a very large number of the agricultural meetings; in particular, we may mention the *Concours general* held at Paris in 1907 under the auspices of all the French railways jointly.

On the *Orleans system*, since 1902, there have been exhibitions and lectures at Bordeaux, Périgueux, Toulouse, Montauban, Issoudun, Blois, Le Mans, Angers, Limoges, Vannes, Carcasson (Midi), etc.

The *Paris-Lyons-Mediterranean* organized in 1906 in Marseilles a very successful exhibition, with special competitions for packers.

These displays were very well received by the agricultural populations; they have certainly extensively contributed to the improvement which has been noted, during the last few years and very generally, in the condition of the packages and in the appearance of the goods; they have not been without effect on the development of the perishables traffic in France.

CHAPTER VII.

Propaganda of the railways for the development or improvement of production.

All the different railway administrations, except those in France, state that they have taken no part in any propaganda among farmers and traders in order to promote the development of the production of perishables and of the traffic in them.

An exception must however be made in the case of the Oldenburg Railway which

mentions that it built a port for the fisheries at Nordenham for the North Sea fishing companies.

With this exception, the care for such propaganda has been left to special State departments and to the farming associations.

In *France*, the intervention of the railways, their co-operation in the official services, only dates a few years back.

The Paris-Lyons-Mediterranean and the Orleans, in particular, have gone far in this direction and in order to show their activity from this point of view, we cannot do better than quote extracts relating to this propaganda, from the reports submitted to the Chamber of Deputies in connection with the agricultural budget for the year 1909.

PARIS-LYONS-MEDITERRANEAN RAILWAY.

The Paris-Lyons-Mediterranean Railway has moreover not confined its operations to these general organizing measures.

Commercial agents. — It has sent, on mission or even to reside there, commercial representatives or agents to Switzerland, Germany and England, who have studied on the spot the markets available in those countries for fruit and vegetables from Algiers and from southern France, who have ascertained what kinds of packages are asked for by buyers or are suited to the taste of the customers, and then have assisted practically and very effectively, by travels, recommendations, lectures, sundry publications, by entering into personal relations with foreign buyers, with French producers and agricultural syndicates, in forming in other countries, particularly in Germany, a connexion for the purchase of French produce.

Finally, since 1905, the company has been publishing and distributing gratuitously, every year to the parties interested, notices containing useful advice on the subject of exporting fruit and vegetables to Switzerland, Germany, England, Belgium and Holland, particularly on the point of arranging the fruit at different seasons in suitable packages.

Packing. — The question of the packing plays in fact an important part in the fruit and early vegetables traffic. It was necessary to find a standard packing, light and strong at the same time, comparatively low in price and giving perfect protection to the contents. The Paris-Lyons-Mediterranean Railway, with the object of realizing this idea, organized a packing competition at Marseilles; it also took an effective part in different packing competitions which were held successively at Paris, in connection with the agricultural exhibition, at Avignon, etc., by placing at the disposal of the organizers medals and even money prizes which were distributed, on its behalf, among the successful competitors.

Under the title of the united producers of the Paris-Lyons-Mediterranean district, it presented French produce, particularly grapes, to the Mannheim exhibition. This particularly-brilliant exhibition, thanks to the quality of the produce sent by our producers, strongly attracted the attention of German visitors, and particularly that of German buyers

On their side the consignors, profiting by the advice that had been given to them, have gradually abandoned their old systems of cultivation and have resolutely entered the path of improved systems of cultivation. The production has been continually increasing and the statistics eloquently proclaim the success of these combined efforts.

ORLEANS RAILWAY.

Commercial propaganda. — The Orleans Railway has for some years been promoting commercial propaganda both among producers and consignors, as well as among actual or possible buyers in France and in foreign countries.

This began in 1902, by employing the special officials, charged with the supervision of the different seasons of fruit and vegetable traffic, to take steps to induce the consignors to improve their packages, the steps taken being personal advice, lectures, exhibitions. Such improvement is in fact particularly desirable in the case of consignments sent a long distance, either to distant markets in the same country or to foreign markets. In addition to the better appearance and the greater sale-value of articles which look well and are carried under better conditions, the damage is avoided which often discourages buyers and leads them to avoïd markets where packages are deficient.

This special propaganda, the packing exhibitions held at the all the points of the Orleans system, as well as the lectures delivered during the winter season, have had the greatest success among the agricultural population. All these factors have contributed to the very extended movement, which can be observed at present and which may affect the conditions of sale of our produce with the happiest results.

The question of the packing is naturally interconnected with that of the markets.

The company considered that the special trade in fruit and early vegetables depended too exclusively on the intermediary of Paris traders, and that it was advisable to favour direct relations between the producing districts and the consuming districts.

With this object in view, special missions were sent not only to foreign countries, such as England, Germany, Belgium, Holland, but also to the principal markets in the north and the west of France which till then were drawing the greater part of their supplies from the Paris markets.

On the one hand, the resources of the producing markets, the advantages of through rates for carriage, were brought to the notice of the traders, on the other, the information collected at these different places was brought to the notice of the consignors by numerous lectures, by newspaper articles, by pamphlets extensively distributed.

Going still further in this direction, the company took the initiative of organizing in other countries exhibitions of fruit from the south west. Such exhibitions were held with very great success in Düsseldorf in 1904, at Liège in 1905, at Cologne nnd Mannheim in 1907, and paid the exhibitors exceedingly well. In particular, the export to Germany of grapes from the valley of the Garonne was started at these exhibitions.

The most recent steps taken in connection with the propaganda consisted of a very active campaign of lectures delivered in the Lot valley, even in the smallest villages, in order to recommend irrigation methods in that valley which is particularly suitable for market gardens; and in connection with this campaign two exhibitions of motors and pumps were held with every success at Cahors and Villeune-sur-Lot.

Finally, at present, the company has hired a stand at the Arts and Craft exhibition of Brussels, for wine-tasting; the wines of Languedoc and of the Garonne basin are shown there, and the company has obtained for the purpose the co-operation of the chief wine-growers' association and of other syndicates of the south. This has quite a remarkable success with the Belgian public, perhaps significant of new export business. Exhibits of fruit, grapes and nuts are also shown in this exhibition.

On its side, the French Northern, by means of its special representative in England, distributed to the English trade a number of circulars giving information, in connexion with these articles of food, about the resources of the different districts in France, as well as the names of the chief firms selling these articles of food.

At the same time, similar circulars were distributed in France giving the names of the chief buyers in the more important English towns.

It must however be mentioned that this very active propaganda did not go on without giving rise to protests of middle-men who, not concerned about future profits bound to result from the general development of the traffic, saw especially the immediate disadvantage of producers and consuming markets being brought closer together.

A complaint was even brought forward by a chamber of commerce; but it was rejected on the grounds of the general interest by the superior administration as well as by the meeting of the presidents of the chambers of commerce.

This propaganda has moreover one important advantage : by bringing railway officials into permanent contact with the agricultural and the trading world, they on the one hand enlighten it as to its own interests, while at the same time they ascertain its desires and hears its complaints; and it is thus made possible to effect continual improvements in the operation of the train services.

What results have been obtained or may one hope to obtain from these novel methods of the goods departments of the railways? So many different factors come into play in the variations in the perishables traffic and react on each other, that it is naturally impossible to deduce the functions of any one of them.

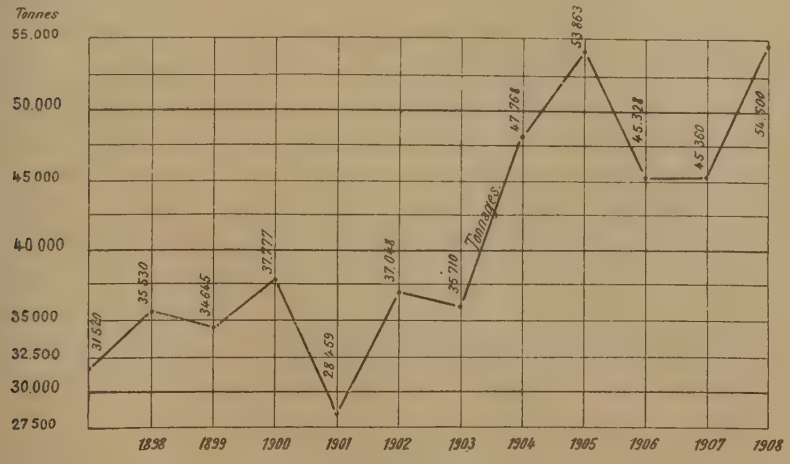

Fig. 23.

Explanation of French term Tonnages = Tonnage.

Nevertheless we have been able to record the direct and very appreciable results which followed from the propaganda in France and in other countries.

Thus for instance we have seen above that the exhibitions organized from 1904 (Dusseldorf) to 1907 (Cologne and Mannheim) resulted in the export to Germany of grapes from the south-west.

We give a curve (fig. 23) showing, from 1897 to 1908, the tonnages of fruit and vegetables sent from the Orleans stations to Paris and beyond (French Northern, export to England and north Germany).

This curve shows a marked increase in this traffic after 1904. Now the activity of these propaganda compaigns dates back to 1902 and 1903, and although the whole progress in the traffic is not to be attributed to them, we may nevertheless assume that it is not totally disconnected.

CONCLUSION.

The principal fact which this examination of the perishables traffic makes clear is that taking it altogether this traffic is progressing considerably.

The increase of the population, the development of general prosperity and well-being, the improvements in land and sea carriage, all help to cause the consumption of these articles of food to increase very quickly everywhere; the continuity of this growth shows clearly that the saturation-point of the international market is far from being reached and that there is still room, and ample room, for all the efforts on the part of exporting countries.

Under these conditions, it is thus not a question of a fight of ejection between these different countries; far from opposing each other, the progress of the one will contribute towards helping the progress of the other; this is shown by the instance of the German market where the new and growing intervention of French trade does not hinder the continuous increase of imports from Italy.

Rather must it be a strife of emulation, in which moreover besides the qualities peculiar to the producers : selection, preparation, condition of the produce, the success will depend less on the rate charged for the carriage than on the care devoted to it, particularly as regards the speed; on the use of suitable rolling stock and on the guarantees given to the consignors by virtue of the conditions of the tariffs.

APPENDIX I.

Milk.

The statistics in annex No. 2 show the great importance and the universal progress in the milk traffic.

This traffic is above all one of very short distances as the following tables show; the one refers to the Berlin supply and the other to the Paris supply; the former is compiled from the statistics for one day, 18 February 1903, by the municipal statistical service of Berlin, the other from information collected in 1892 and 1902 by the railway administrations,

DISTANCES.	Arrivals at Paris by rail.				
	Tonnage.		Differences.		
	1892.	1902 (1).	—	+	Per cent.
	Tons.	Tons.	Tons.	Tons.	Tons.
Up to 25 kilometres.	1,995	166	1,829	...	...
26 to 50 —	46,426	53,854	...	7,428	16
51 to 75 —	60,161	89,734	..	29,573	47
76 to 100 —	37,393	71,571	...	34,178	92
101 to 125 —	6,270	27,932	...	21,662	35
126 to 150 —	2,709	6,946	...	4,237	157
151 to 175 —	92	4,677	...	4,585	498
176 to 200 —	..	...	..	...	...
201 to 250 —	...	45	...	45	...
251 to 300 —	25	...	25	...	...
301 to 400 —	...	200	...	200	...
exceeding.	...	371	...	371	...
Total. . .	155,071	255,496	+	100,425	65

(1) In 1902: mean distance, 77·25 kilometres; mean receipts, 10·49 francs per ton, 0·136 franc per ton-kilometre 0·013 franc per litre of milk of gross weight of 1·25 kilograms.

Arrivals at Berlin by rail on 18 February 1903.

Distances.	Quantity (1).	Distances.	Tonnage.
	Tons.		Tons.
11 to 20 kilometres . . .	19·909	91 to 100 kilometres . . .	23·015
21 to 30 —	60·779	101 to 120 — . . .	39·866
31 to 40 —	176·272	121 to 150 — . . .	8·780
41 to 50 —	96 888	151 to 200 — . . .	0·902
51 to 60 —	88·500	201 to 250 — . . .	0·216
61 to 70 —	81·298	251 to 300 — . . .	0·025
71 to 80 —	67·378	exceeding.	0·027
81 to 90 —	66·105	Total. . .	729·960

(1) Weight of cars included.

According to these two examples, consignments from distances exceeding 125 or 150 kilometres (77 or 93 miles) are rare; the instance of Paris, in particular, shows that in order to meet the considerable increase of 65 per cent in its needs, much the greater portion, namely 94 per cent, has been found in this zone of 150 kilometres (93 miles).

The rates for the carriage have but a slight influence on this state of affairs.

It depends, as we know, on the special difficulties of this traffic, on the churning effect produced by the continued vibrations taking place during a long journey, on the necessity of completing a very large number of complicated operations in the short interval between the evening milking and the distributions to the consumers at about 7 o'clock the next morning; such as the collection from the farms which are often at a distance, the Pasteurization, the dispatch, the carriage, the delivery, to destination in town.

However although the influence of the rates for carriage is but small, it must nevertheless not be neglected.

We note in fact that out of 5,385 tons brought to Paris in 1902 from distances exceeding 150 kilometres (93 miles), 5,148 tons were carried on the French Eastern Railway which offers by far the most reduced tariff.

The Orleans Railway reduced in 1905 its tariffs for distances above 120 kilometres (74·5 miles) quite appreciably; the consignments (gross weight) from these greater distances increased from 1,200 tons in 1905 and 1,000 tons in 1906, to 3,100 tons in 1907 and 5,000 tons in 1908.

In Germany during the recent "milk war" in 1905 between the rural producers and the Berlin middlemen, the latter, in order to escape the raised prices which it was desired to impose on them, had to draw their supplies from considerable distances, up to 300 and 500 and even 600 kilometres (186 and 310 and even 372 miles), from Jutland (Denmark).

The rates for the carriage are thus not wholly negligible; this can be understood *a priori* if one considers that the disputes between producers and consumers turn on centimes or fractions of centimes per litre, that these differences become of importance on account of the great quantities

dealt with, and quickly, and that finally, for instance, a difference of 4 francs per gross ton or say 0·005 franc per litre (3*s*. 3·02*d*. per English ton or 0·218*d*. per English gallon) net would in fact represent 5 per cent on the price of the article sold at 10 centimes per litre (4·362*d*. per English gallon) at the farm; that is by no means a negligible fraction of the profit made in this particular line.

However here again it is not possible to consider a systematic lowering in the rates; in examining such a question it must be taken into consideration whether nature, the conditions of cultivation, the rural habits in the new districts which are being considered lend themselves to the production of milk. Even the state of the cattle market has an influence, for we may see, at Beauce for instance, that the production of milk varies with the prices of sheep, of calves; for the farmers tend, if these prices rise, to replace the rearing of cows by that of sheep or to replace the production of milk by the fattening of calves.

Finally, in order to enable reductions in the rates to give any results, it is essentially necessary that the train service is suited to this special traffic.

As it is necessary to collect the milk, after the milking, from farms which are often a long way off from the railway, and to Pasteurize it at depots near the stations, the milk can hardly be sent off before 7 or 8 p. m.; on the other hand in very large towns, owing to the time necessary for delivery at the station, to the extensiveness of the distribution services in the different quarters, above all in the case of stations which are distant from the centres, the last limit for the arrival of the trains seems to be 1 to 2 a. m.

These limited hours peculiarly restrain the distances over which this traffic is practicable; it is consequently evident that the question of the tariffs and that of the transporting operations itself cannot be separated and that they must be studied simultaneously, the second being even more important than the first.

It is moreover in this way that the administrations have proceeded who have given us their special tariffs for this traffic, for nearly all these tariffs have as characteristic the prescription of all the measures favourable for simplifying and shortening the necessarily-hurried operations at stations.

Thus in Germany for instance, the concession of applying the broken-load slow-freight tariff to this traffic which is carried as quick freight, which is generally granted to the greater number of the perishables without particular reservations, is in the case of milk subjected to a whole series of conditions helping to shorten the operations at the dispatching and at the receiving stations.

From this particular point of view, the special tariffs communicated by the administrations of the Prussian State, the Saxon State and the Wurtemberg State give rise to a certain number of observations to which it seems of interest to draw, at least summarily, the attention of other administrations.

In the first place, without making these tariffs into subscription tariffs, strictly speaking, the administrations of the Prussian State and the Saxon State ask the consignor to submit in advance a proposal of traffic, the number of cans to be consigned per day and the trains desired, so as to be able to regulate in this way their means of transport.

Nearly all the work at the forwarding and at the receiving stations is then eliminated by the following measures :

1° The consignors and consignees handle the goods at the stations;

2° In all cases the rate is charged according to the weight or capacity stamped on the cans or

recipients, even if this is not full, the weight charged, in the cases in which the capacity is stamped on, being 1 kilogram per litre (10·02 lb. per English gallon), on the Prussian State (returned empties being charged for), and 1·50 kilograms per litre (15·03 lb. per English gallon) on the Wurtemberg and Baden States (empties returned free);

3° The cans must have metal addresses of a given form and size, on which the weight or capacity is engraved, together with the name and address of the consignor and the consignee. The Saxon State even goes so far as to state that these addresses must be legible by artificial light;

4° The railway has the right of demanding that the upper part of all the cans of one and the same consignment shall be painted a uniform colour;

5° The capacity of the cans must not exceed 40 litres (8·8 English gallons), and the weight of the cans must not exceed 40 kilograms (88 lb.) (50 litres or 50 kilograms [11 English gallons or 110 lb.] on the Wurtemberg State);

6° The clerical work is reduced; the consignor has to draw up and supply way-bills, or the forwarding station keeps a simple monthly account;

7° The empties are returned on receipt of instructions;

8° No advices of arrival are sent out;

9° The carriage is paid at the start, or else accounts are settled every month by the consignor or the consignee, proper guarantees being given.

In addition to the different facilities afforded by these different measures for accelerating the transport itself, the Prussian State and Wurtemberg State administrations receive consignments of milk not only at the stations on their lines but also at a number of intermediate stopping places; this arrangement which is well calculated to facilitate and accelerate the preliminary collecting work, may also be useful in order to facilitate the establishment of depots which is often difficult or impossible in the immediate neighbourhood of the station.

The tariff of the *Swiss Federal Railway* is a *subscription* tariff in two parts.

The first concerns daily consignments consisting of at least 25 litres (5·5 English gallons) consigned *in one lot per day*.

There are three scales of rates according to whether the subscription is for periods of less than 3 months, or for a period of from 3 to 6, or 6 to 12 months; the rates are fixed in indivisible fractions of 5 litres (1·1 English gallons) and include the return of empties free.

Payment is made in advance and the consignor receives in exchange for this payment a number of metal checks representing 0·30 franc (2·88*d*.) each; these are fixed permanently to each can and must not be taken off until the time when the subscription lapses.

As these checks are paid for in advance, all work beyond a simple control is eliminated at the stations.

Extra facilities are moreover granted in the case of all consignments consisting of cans all *having the same capacity*, not exceeding 60 litres (13·2 English gallons).

The second part of the tariff includes the rates payable, in the way of subscriptions, for daily consignments of 1,500, 5,000 or 10,000 kilograms (3,300, 11,020 or 22,050 lb.) per wagon used; these rates are lower than those in the first part of the tariff, at least as far as short distances are concerned, which are of particular importance in the case of this tariff.

In the conditions of this second part we also find detailed prescriptions intended to facilitate the station work.

The cans must be of uniform capacity not exceeding 60 litres (13·2 English gallons).

The cans have to be gauged and stamped.

When not weighed, the weight is calculated at 1·30 kilogram per litre (13·02 lb. per English gallon) of capacity gauged.

The consignor must draw up special way-bills, and all the station has to do is to check them.

The handling is done by the public.

The payment for the subscription is made in advance unless the railway authorizes monthly settlement of the charges for the carriage.

We also see mentioned that wagons are placed, free of charge, at the disposition of the consignor, who can equip them, at his own expense, and that there is an option to make up the loads at intermediate stations, paying however the rate on the full weight from the station at which the wagon starts.

The tariffs of the French railways are very far from presenting such a series of regulations.

We only find it stated, in a general way, that the public must handle the goods at the start and at arrival; and that empties are returned either free or on payment of a booking fee of 0·10 franc (0·96*d.*) and of the tax of 0·70 franc (6·72*d.*).

The tariff of the French Western also contains the proviso that the 2,500 kilograms (5,500 lb.) required in order to benefit by the reduced accelerated slow-freight tariff can be made up at intermediate stations.

Some administrations specify that the weight to be charged for is to be calculated from the capacity of the cans, the French Eastern specifying 1·35 kilogram per litre (13·52 lb. per English gallon) and the Orleans specifying 1·25 kilogram per litre (12·52 lb. per English gallon).

However, in spite of the absence of such conditions in the tariffs of other countries, the service is generally carried out quickly and sufficiently simply, owing to the natural desire of the consignors for quickness, and also, as far as consignments to Paris are concerned, owing to the general use of metal cans known as "*pots de Paris*" having a standard capacity of 20 litres (4·4 English gallons).

The rolling stock used for the carriage of milk does not as a rule present any special features. Nearly everywhere, in order to increase the useful load of these wagons, double-deck wagons are used, which have however the disadvantage of requiring more time and trouble for loading, particularly in the case of broken loads at intermediate stations.

In hot countries or countries of medium temperature like France, these milk vans are constructed with lattices so as to cool the milk by the cold of the night or by the air currents produced by the movement of the train. Ordinary platforms fitted with extra tops are also used for this purpose.

In countries with a lower winter temperature, the tendency appears to be to use wagons with double walls.

The use of refrigerator vans is but little extended and apart from some exceptional cases where the distances are great, it does not appear necessary as the distances are generally short.

Their use will perhaps become more developed in the future with the extension of the zones from which supplies for large cities will be drawn. It must however be mentioned that according to some experiments recently made in connexion with the traffic to Paris, their use for the

carriage of milk will not be unattended with difficulties; for in spite of quite particular care as regards cleanliness, no success has been yet attained in completely overcoming the bad smell which after a very few voyages established itself in the wagons.

It will no doubt be possible to overcome this difficulty and in that case the refrigerator van will be useful not only for the conveyance proper, but also as a store for receiving the morning milking and keeping it while awaiting dispatch after the afternoon milking.

APPENDIX II.

Sea-fish.

Sea-fish has the quite special character of having for a long time been considered an article of food of luxury, and it is still considered as such. In districts far away from the shores, it only very slowly becomes an article of ordinary consumption.

It is for this reason that while the consumption of the ordinary articles of food (vegetables, fruit, meat, butter, eggs, etc.) grows with the purchasing power, that is to say, with the more general prosperity of the comsumers, with the abundance of the supplies brought to market, there has to be in the case of sea-fish a special development in the taste and the habits of the customers.

Thus to the attention devoted to the continually-growing traffic in perishables generally, we have in the case of sea-fish to take special care, on the one hand, in order to facilitate the establishment and development of this special industry of fishing; on the other hand, in order to form a connection of new consumers for this purpose.

Conforming with the logic of this situation, a very large number of administrations have devoted to this traffic greater attention and granted more facilities than in the case of the other perishables.

Some of them have paid most attention to the consumer, and have tried to win him over by reducing their rates, by supplying fresher fish by means of accelerating the traffic, by allowing the division of the consignments to suit the daily needs, etc.; the others have above all devoted themselves to giving all the facilities possible in their land operations to the fishermen and more especially to new fishing undertakings and to steam trawlers.

No doubt there is no absolute line of demarcation between these two methods, and some of the administrations have applied them both simultaneously. But without wishing to draw a formal conclusion, it may nevertheless be shown that even if the future of this traffic depends largely on the care devoted to it by the railways, it is more especially and essentially dependent of the development of the sea fishing itself.

A first example in this connection is shown by the progress of the fishing port of Ymuiden in Holland, where the sales of fish in the market increased as follows :

299,000 mark	(£14,950)	in 1888
560,000 —	(£28,000)	in 1891
1,860,000 —	(£93,000)	in 1900
3,107,000 —	(£155,350)	in 1903
4,073,000 —	(£203,650)	in 1905

Now this growth is to be attributed above all to the progress of the steam-trawling industry,

*

the number of trawlers entering the port having increased, for instance, from 2,754 in 1903 to 3,578 in 1906, codfish boats not included.

It appears evident in fact that on account of the small size of Holland, the government and the railways of that country can only act on a limited Hinterland.

It is however true that the Rhine navigation and consequently the competing tariffs of the railways in the Rhenish districts have given important facilities to this penetration.

The very quick extension of the trade in fish at Geestemünde, at the mouth of the Weser, can also be attributed above all to this development in steam trawling; it is shown in the following table.

YEAR.	Tons of fish caught.	YEAR.	Tons of fish caught.
1896	13,200 tons.	1903	25,200 tons.
1897	13,500 —	1904	25,600 —
1898	14,300 —	1905	28,700 —
1899	14,800 —	1906	36,700 —
1900	16,400 —	1907	35,000 — (1)
1901	17,700 —	1908	31,700 — (1)
1902	22,300 —		

(1) Competition with the port of Cuxhaven at the mouth of the Elbe.

Now this progress certainly seems largely due to the development of steam trawling, as there were four such trawlers in 1887, and this number increased to 37 in 1897 and to 160 in 1905.

The German railways who from 1893 on applied their brokenload slow-freight tariff to the quick-freight traffic in fish as well *as to that in all other perishables*, subsequently introduced, it is true, very reduced rates of special tariff No. S 18 for consignments sent for the German fishing ports only; but if we examine the destinations which benefit by these low rates, we only find stations in Western Germany, in the basin of the Rhine. It therefore seems that this tariff, which begins at the distauce of 200 kilometres (124 miles), has as its object not to facilitate the development of consumption by reducing the cost of carriage, but to assist the German fishing ports in their competition against the Belgian and Dutch ports.

Finally, a very typical instance of the paramount influence of the development of the production on the increase in the consumption is given by the progress of this traffic during the last few years at the stations of the Orleans Railway, which caters for the fishing ports on the south shores of Brittany.

The ports we will thus compare are Pont-l'Abbé, Douarnenez and Concarneau, where only sailing boats are used for fishing, and Lorient, where the use of steam trawlers has been growing the last few years to some extent.

These ports which are very close together are subjected to the same tariffs, and are served by the same trains; thus they are placed under absolutely-identical conditions, so that the results obtained in this case is absolutely conclusive.

Total tonnage of fish traffic from the stations at the ports named below.

YEAR.	Douarnenez.	Pont-l'Abbé.	Concarneau.	Total for these three sailing-boat ports.	Lorient.		
					Tonnage.	Percentage as compared with the tonnage of the three former ports.	Number of steam trawlers.
	Tons.	Tons.	Tons.	Tons.	Tons.		
1904	3,200	2,194	738	6,132	1,745	29	...
1905	3,993	2,714	980	7,687	2,601	34	...
1906	3,601	3,352	1,037	7,990	2,528	32	6
1907	3,901	3,483	1,043	8,427	3,767	45	7
1908	2,976	2,891	681	6,548	6,853	105	12

Thus although the railway takes no special measures, the influx of the fish into the fishing ports thus by itself acts as a certain stimulus to the consumer of the interior, producing, so to say, a spontaneous development of the consumption; this stimulus acts although in spite of the increased supply, the price of the fish tends to rise, if we may believe a report presented 28 January 1908 by Mr. Marcel Charrier to a commercial reunion at Lorient; in this report it is stated that at Boulogne the average price of fish was 0·62 franc per kilogram (2·70*d.* per lb.) in 1894 when steam fishing began, and had increased to 0·785 franc per kilogram (3·42*d.* per lb.) in 1901.

The information as to the increase is confirmed by a paper on *La pêche française à la fin de 1908*, published in the *Bulletin de la ligue maritime française* of April 1909; in it the author gives the following prices for fresh fish at Boulogne : 0·52 franc per kilogram (2·26*d.* per lb.) in 1891; 0·65 franc per kilogram (2·83*d.* per lb.) in 1901; 0·88 franc per kilogram (3·83*d.* per lb.) in 1906. It is interesting to compare these figures, in the following table, with the tonnage of fresh fish dispatched from Boulogne station and with the number of steam trawlers at that port.

YEAR.	Price per kilogram of fresh fish, not including herrings, mackerel and cod.	Quantity of fresh fish dispatched.	Number of steam fishing boats.
1891	52 centimes.	12,500 tons.	3
1901	65 —	27,200 —	55
1906	80 —	45,700 —	108

Finally, similar observations have been made in England where the average price of fish caught

increased from 0·243 franc per kilogram (1·06*d*. per lb.) in 1886 to 0·2716 franc per kilogram (1·183*d*. per lb.) in 1905 (1); and also at Geestemünde where the price increased from 0·26 franc per kilogram (1·13*d*. per lb.) in 1896 to 0·32 franc. per kilogram (1·39*d* per lb.) in 1905 (2); it is true that this price has fallen since.

These repeated instances seem to show clearly that the administrations who devote their efforts to the development and the improvement of the fishing ports, to the facilities to be given at those ports for the victualling of the boats and for the dispatching of the fish, are taking good measures for the development of this special traffic.

In the countries in which the iron roads belong at least to a large extent to the State, such as Germany and Holland, the State, for instance at Geestemünde, at Cuxhaven, at Ymuiden, undertakes the work of constructing these fishing ports and of equipping them ; in England, where the private companies have a happy tendency to consider the ports as their natural extensions (the London and South Western Railway has for instance made of Southampton a very imporant port., it is natural that one of them, the Manchester, Sheffield and Lincolnshire Railway (now the Great Central) should have built and equipped the port of Grimsby, the fishing fleet of which included 489 steam boats and 40 sailing boats in 1903; its fish traffic has increased from 47,600 tons in 1880 to 72,400 tons in 1890, to 130,000 tons in 1901, and to 164,000 tons in 1903.

Moreover, even if we leave out of consideration the development of the traffic and the profits which the railway has consequently earned, these maritime enterprises would not cease to be profitable.

At Grimsby for instance, the total revenue of the port (fish and trade) rose from 814,000 francs (£32,560) in 1891 to 1,780,000 francs (£71,200) in 1905 and to over 2,000,000 francs (£80,000) in 1908, for a total outlay of 15,760,000 francs (£630,400). This would form a very profitable investment yielding 11·3 per cent.

To describe the arrangements at these ports does not enter into the scope of this note; it is enough to say that efforts have been made to reduce to a minimum the different operations as between the boats and the market and the stores of the dealers, and between these stores and the wagons or the forwarding stations. Every advantage has been taken of the local conditions so as to concentrate the installations and thus reduce to the lowest possible limit the cost of handling, both as regards the fish and the victualling of the boats, coal, ice, etc.

Without entering into all these details, it seems however of interest to mention part of the organization devised to facilitate the dispatching operations and to accelerate them, an acceleration which is particularly necessary at Grimsby as sometimes on busy days more than 300 wagons are sent off.

In this port there is an arrangement, which is as interesting as it is simple and practical, which makes it possible to accelerate the loading operations to an important extent.

Three trains consisting of empty wagons which have to be loaded are placed on three parallel tracks which are alongside the platform on to which the offices of the dealers open ; the railway servants have the consignment notes and take and weigh the ready packages which are placed

(1) In 1886 : 565,433 tons valued at 127,287,000 francs (£5,091,480). In 1905 : 973,636 tons, valued at 246,245,000 francs (£9,849,800).

(2) In 1896 : 13,190,954 kilograms (29,081,057 lb.), valued at 3,436,680 francs (£137,467.4*s*.). In 1905 : 28,687,781 kilograms (63,245,690 lb.), valued at 9,303,827 francs (£372,153.2*s*.).

outside the offices, and at once load them into the most distant train, crossing by means of travelling cranes the wagons of the empty trains which are in between.

As soon as this train is loaded, it is removed and another empty train is shunted into its place; in the meantime, without interrupting their work, the loaders in the same way get the second train ready: by means of this system which reduces the number of operations to a minimum, a period of three quarters to one hour is enough for loading a train so that it is ready to start.

At Geestemünde, as at Grimsby, the consignments are taken from the stores of the dealers by the railway which weighs the packages and fills in the consignment notes.

The loading is however not done right opposite the market, but the packages are conveyed by four-wheeled trollies to the loading stages, which are covered and are three in number, with tracks on each side, and can hold altogether 30 wagons.

For this work the railway charges 1 mark per ton (1*s*.0·19*d*. per English ton).

The time necessary for getting a train ready to start is about two hours, which is the time the railway fixes for the consignors.

In order to shorten this time, it was proposed to ask the consignors to sort their packages themselves, which could then be placed on special trollies and taken direct to start for their destinations.

It is also proposed to use electric traction for the trollies which carry the fish from the stores of the dealers to the wagons which are being loaded.

At Cuxhaven, the port and its installations are managed by the Hamburg State authorities; among their staff they have a "chief consignor" who appears to represent the consignors with the railway and whose intervention in such cases materially simplifies the operations.

While at Geestemünde all the loading is effected at the dispatching station, at Cuxhaven on the other hand loading tracks placed along the market make it possible to load *full* truck-loads on those sidings.

At most of the fishing ports of the other countries, particularly in those of France, they are as yet far removed from such favourable conditions, from this endeavour to realize the smallest economies in the movements of the boats, in the handling of their fish and in their victualling.

At Boulogne for instance, which is the most important French fishing port, two carting operations are necessary, one from the port to the store of the dealer, the other from that store to the station, and very often even a third, if the fish goes to the nearest market to be sold by auction.

These troublesome and slow operations, which are repeated with the coal, with the ice, with all supplies, are a heavy burden on the steam fishing, which requires the greatest speed in all these operations so as to reduce to a minimum the time lost on land, and enable it to amortize its large capital outlay and utilize its staff to better advantage.

In addition to the other causes of dearness special to French shipping; high price of coal and ice, bad organization and high auction dues, for which concessions have been often granted to concessionnaires who have nothing to do with the fisheries, these bad conditions of the work at the ports no doubt exercise their influence on the comparatively-high price of fish in France.

In a very documented work on *L'Avenir du port de Lorient*, published in 1909, we read that in 1907 the wholesale price for fish, the average for all kinds, did not exceed :

0·35	franc per kilogram	(1·52*d*. per lb.)	at Ymuiden;
0·25	— —	(1·09*d*. —)	at Geestemünde;
0·25	— —	(1·09*d*. —)	at Hamburg (Cuxhaven);

while in France the average rose to 0·54 franc per kilogram (2·35*d*. per lb.) which is more than double the price averaged in the German ports.

This difference is perhaps partly due to differences in the kinds of fish caught; it cannot, however, be doubted that the defective arrangements at the port play an important part in this exaggerated price which bears heavily on the sea-fish traffic; they certainly contribute in France to the slow development of steam trawling, which is today the essential tool in the progress of fisheries; and yet steam trawlers had their origin in France.

It must moreover be taken into consideration that the multiplicity of the ports, their dispersion along such an extended and broken up coast as that of France, creates *a priori* a much less favourable situation for large steam-trawler enterprises than in Germany, where on the flat shores of the Baltic and of the North Sea there are but few ports, nearly all at the mouth of rivers.

All these reasons explain the difference of the situation which is shown in the following table :

—	France in 1906 (2).	Germany in 1907 (1).	England in 1906 (2).
Sailing boats.	25,000	442 (*a*)	10,000
Steam boats	200	208	2,000
Percentage proportion, steam to sailing	8	47·06 (*b*)	20

(*a*) Only the sailing boats fish outside the territorial water.
(*b*) Only with reference to the deep-sea fishing sailing boats.

In order to counterbalance these greater initial charges, attempts have been made in several countries to improve the conditions of carriage : rate and speed.

In Germany for instance, the organization of the ports being considered satisfactory, sea-fish is carried under the same conditions as all other perishables, except in the case of the very reduced rates of the competition tariffs; in Switzerland, in order to facilitate the arrivals from places which are naturally a long way off, the slow-freight tariff is exceptionally applied to consignments carried as quick freight : in France, as we have seen in chapter II of this report, much lower rates are applied to fish, both for the home tariff and for export, than to all the other perishables.

It seems useless to refer again to the details given in the body of our report, on the scales of rates included in the tariffs of the different countries, on the conditions of speed which are realized; we shall here limit our examination to the questions arising in connection with this particular traffic.

In certain countries, especially in France, its expansion is hindered by the *octroi* levied when entering towns, *octroi* which is frequently so high that it seems based on the old conception of fish as an article of luxury.

Thus an article of food which is sold at the ports at 0·50 franc per kilogram (2·18*d*. per lb.) or even at 0·20 franc per kilogram (0·87*d*. per lb.) in the case of herrings, has to pay duties which amount to 0·40 franc per kilogram (1·74*d*. per lb) at Valencia, 0·25 franc per kilogram (1·09*d*. per lb.) at Havre (1), 0·20 franc per kilogram (0·87*d*. per lb.) at Nimes, and which as a rule reach 0·15 franc per kilogram (0·65*d*. per lb.), as at Toulouse, Avignon, etc.

(1) For sea-fish imported direct without passing through the municipal auction.

These duties which exceed, and that considerably, those levied on meat, which fetches, however, a much higher price, certainly hinder the consumption of fish as an economic article of food particularly useful to the working classes.

A recent enquiry (*Congrès national français des pêches maritimes*, 1907) has shown that the mean annual consumption per inhabitant did not exceed 2 kilograms (4·4 lb. at Lyons, 3 kilograms (6·6 lb.) at Toulouse, 4 kilograms (8·8 lb.) at Lille, 5 kilograms (11 lb.) at Roubaix, and 9·5 kilograms (21 lb.) at Tours and Orleans, while it amounted to 17 kilograms (37·5 lb.) at Nantes and to 32 kilograms (70·5 lb.) at Nice.

Even if we do not count the rural populations who entirely ignore this article of food, we see that there still is ample room for development.

During the course of the enquiry just mentioned, several municipalities which levy duties of up to 150 francs per ton (£6.1*s*. 11*d*. per English ton), thought it advisable, quite forgetting these exorbitant duties, to recommend the reduction of the rates for carriage as a means of promoting this development; it does not, however, seem that such a reduction which perforce could only amount to a few centimes per kilogram, could have any appreciable useful effect

This is proved by the very table of the consumptions at a number of French towns, according to which for instance, Lyons, where there is no octroi duty, shows the low consumption of 2 kilograms (4·4 lb.) per year, while Poitiers with an octroi duty of 0·15 franc per kilogram (0·65*d*. per lb.) shows a consumption of 10 kilograms (22 lb.) per year.

The future of this traffic depends above all on the education which the producers must try to give to the consumers, for instance by facilitating the supplying of large bodies : troops, educational institutions, workmen's cooperative societies, etc., where the taste of the consumers might become developed; by trying to come into closer touch with the consumers by reducing, eliminating or changing the middlemen who by ancient custom, or to cover the risks inherent to this retail trade, sell at present too frequently at much increased prices.

Attempts have already been made in this direction; the fish dealers of Boulogne, Arcachon, etc. have thus entered into direct relations with troops, hospitals, educational institutions, etc.; the important North Sea Fisheries Association, of Nordenham, has established shops for selling direct at a large number of German towns and also at Vienna, Budapest, Bale, etc.

But there is still much to do in this direction and the railways might with advantage study the measures necessary for seconding such organizations.

Moreover a reduction in the railway rates is not a particular wish of the fishing industry; it was not mentioned at the French *Congrès national des pêches maritimes* of 1907; it is not on the list of proposals submitted by the fish dealers of Boulogne to the new 1909 Congress.

Among the list of the wishes of a general character at this Congress, wishes which certainly represent the universal feeling of this special trade, we find the following demands which are repeated more emphatically :

1° Reduction of the time required for the operations at the stations, and admission of the sea-fish into the fastest trains;

2° Application of the tariffs for the quickest routes (instead of the shortest);

3° Reduction of the minimum weight for the application of the special tariffs;

4° Telegraphic advice to the consignor in case of non-delivery at arrival;

5° Reduction in the weight to be charged for, owing to its reduction on the way by the melting of the ice.

As regards the first point, all the administrations in all the countries try to give in practice as much satisfaction as possible; this is more than proved by the information, contained in this report, about the measures taken everywhere with a view to acceleration, and about the results obtained; we have also shown how in France the railways have been led to guarantee these results.

As regards the selection of the quickest routes, we repeat the wish we have already expressed to see this valuable proviso inserted among the conditions of international tariffs, as has been done in the case of the French home traffic.

The question of the lower limit of the weight of the consignments appears to be peculiar to France, where the French Northern has however reduced this limit to 20 kilograms (44 lb.).

In Germany in fact, according to the general conditions of application of the tariffs, the minimum limit of the rates is reduced to 30 pfennigs (3·6*d.*) for broken loads rated under the slow-freight tariff applying to such consignments.

The Italian quick-freight tariff No. 3 fixes it at 20 kilograms (44 lb.); and so on.

The extreme division of the consumption of sea-fish explains the interest which the dealers always assert they have in arrangements organized to facilitate the distribution of their consignments even to the smallest places.

The importance of this may well be gauged by the fact that in 1905, at Boulogne, the number of postal parcels, maximum weight 10 kilograms (22 lb.), was 246,271; these represent, taking 5 kilograms (11 lb.) as the average weight, nearly one third of the whole tonnage dispatched from the station.

This traffic in small packages, sent direct to private people, to small dealers, to schools, has assumed a considerable development in England, in spite of the importance of the general traffic.

According to a report made by one of the French Northern missions, the number of such consignments, packed in light straw fish baskets with handles and weighing, ice included, from 1 kilogram (2·2 lb.) upwards, sent per day from Grimsby, amounts to about 700 and sometimes reaches 1,200; it reaches 4,000 during Lent.

These small packages of fish are charged half the ordinary parcels rates; and if we compare these rates with say the French postal parcel rate, we find material advantages, particularly in the case of the lighter weights, as shown in the following table:

WEIGHTS NOT EXCEEDING.	Rates	
	French.	English.
1 kilogram	0·40 franc.	0·85 franc.
3 kilograms	0·60 —	
5 —	0·90 —	1·05 —
7 —	1·00 —	1·25 —
10 —	1·20 —	

This question of reduced rates for the lower weights seems deserving of attention.

The advantage of advice by telegraph in the case of non-delivery at arrival is evident; the

dealers are thus enabled to take immediate measures for finding other consignees for their goods.

In France, in spite of the offer of the consignors to pay the cost of this advice, resistance to this measure continued for a long time, for fear of introducing new complications in the station service where there are already so many details which have to be attended to. Some administrations have, however, recently decided to make a trial, and this trial is at present going on: it will be interesting to know what results are obtained.

The question of charging on a lower weight than the consignments actually have at the start, in order to allow for the ice melted on the way, is answered in the negative by the majority of the administrations who adhere to the general rule of charging on the actual weight at the start.

No doubt they have thought that a derogation from this general rule would give occasion for other similar demands in the case of other goods; without however attacking this principle, the question could be solved otherwise by a modification of the tariff itself.

In the answers sent to this special question, there are only some German systems, among them the Prussian State and the Bavarian State, which mention that in the case of consignments of fish packed in ice, an allowance of 5 per cent is made in the initial weight.

This question of allowance in the weight to be charged arises in a perhaps more importunate form in the case of live fish conveyed in water, as the dead weight represented by the water necessary is very considerable. The answers of the different administrations give no information about the importance of this special traffic. But if one may judge from the details of the uniform regulations which the different railways of Central Europe have taken the trouble to draw up, we may assume that such traffic is at least fairly frequent.

In France, it is limited to a few consignments of fresh-water fish sent in metal tanks filled with water.

In no case is any reduction made for the weight of the water, and these consignments are charged at the rates of the ordinary tariff for fish.

The uniform regulations mentioned above which exist in Central Europe only include a reduction of 2 pfennigs per kilometre (0·39*d*. per mile) in the fare of the attendant in charge when travelling in the special wagons for looking after the air-circulation mechanism.

Certain administrations draw distinctions between the different kinds of fish, according to their value, and apply more or less reduced rates accordingly.

In Germany for instance the series of exceptional tariffs S 18, for consignments from German ports to the western districts, includes a tariff S 18*b* applying to *herrings*, with rates which are materially lower than those for others kinds of fish.

For instance, the rates from Kiel to Frankfort (chief station) are 25·20 and 21·30 marks per ton (£1.5*s*. 7·25*d*. and £1.0*s*. 9·95*d*. per English ton) in tariffs S 18*a* (fish generally) and S 18*b* (herrings respectively.

On the Russian railways the divisions are more numerous.

In fact it seems anomalous to charge fresh herrings, which have an average selling price not exceeding 0·25 franc per kilogram (1·09*d*. per lb., at the same rate as turbots and soles, which sell at 2·50 and 4·00 francs per kilogram (10·89*d*. and 1*s*. 5·42*d*. per lb.).

The *octroi* offices moreover draw this distinction between the various kinds and generally divide sea-fish into two or three classes on which different duties are paid.

But except in the case of herrings, in which there is considerable traffic at certain times of the

year, the consignments generally consist of different sorts: in consideration of the conditions under which the consignments are dispatched at the forwarding stations, it seems practically impossible to ask these stations to do the work of checking the consignments in such a way as to prevent wrong duties from being charged.

It is remarkable to note that the wishes of the congress referred to above, do not contain any reference to refrigerator vans.

Besides the advantages inherent to the use of such stock for an article of food so eminently perishable, there is in this case the very special advantage of a reduction of weight in the ice placed in the packages and of a corresponding economy in the cost of purchasing and carrying this ice.

But in the home traffic of each country the actual time required is generally so short that this use does not seem necessary.

We have however seen in the chapter dealing with the means of conveyance, that trials are actually being made by various administrations. Traders on their side also show tendencies to utilize these wagons in the case of long-distance international traffic, and these tendencies are naturally to be encouraged.

The use of refrigerator vans is especially very advantageous in the case of crustaceans; in the case of consignments sent from the south coast of Brittany to Belgium, their use has made it possible to reduce very materially the mortality of these animals, a mortality which was often very high when they were carried under the ordinary conditions.

As regards the use of cold for facilitating and regularizing the development of this sea-fish traffic, wishes have been expressed in favour of installing cold storage at the fishing ports.

These stores should receive the fish and store it in dry air with a temperature sufficiently low to preserve it, but not to freeze it, as this would depreciate its value on the European markets.

Instead of the sudden rushes which now result from the daily chances, sometimes favourable and sometimes otherwise, of the fishing, the sales could then be regularized, the excess on days of abundance being stored to supplement the deficiency on days of scarcity.

We can understand that the railway administrations would undertake on their own account the construction and the management of such stores, with a view to the development and the regularization of their traffic. The Orleans Railway studied the question closely in connection with the fishing ports on the south coast of Brittany. It has abandoned these projects, at least provisionally, owing to the difficulties and the want of success it expected to encounter through the indifference of the dealers.

APPENDIX III.

Fresh-cut flowers.

Fresh-cut flowers are essentially a long-distance traffic; thus they are quite the opposite of milk, which as we have seen is nearly entirely a short-distance traffic.

It is perhaps the most delicate article among all the articles carried, the least alteration removing all its value; it requires all the more speed and care, as this traffic is chiefly carried in winter, a season which is particularly dangerous to flowers.

It is only owing to this care and to the speed given to it everywhere, that this comparatively recent (1) traffic has been able to assume the importance it has now assumed, as shown in the following table applying to the systems more especially interested in this traffic.

Tonnage (in tons).

YEAR.	South Russia.		Italian State (Liguria).		Paris-Lyons-Mediterranean. (Provence).		
	Total.	part exported.	Total.	part exported.	to Paris.	for export.	Total.
1900. . . .	1,662	4	...	...	...	...	...
1901. . . .	1,661	9	...	..	..	...	...
1902. . . .	1,862	4	...	...	...	...	...
1903. . . .	2,354	10	...	...	...	...	...
Winter 1903-1904.	...	...	...	..	2,692	4,436	7,128
1904. . . .	2,660	15	...	...	...	...	...
— 1904-1905.	...	...	...	...	2,037	4,160	6,197
1905. . . .	2,470	7	..	..	...	...	...
— 1905-1906.	...	...	...	...	2,648	4,093	6,741
1906. . . .	1,538(*)	9	...	...	...	...	...
— 1906-1907.	...	...	2,014	1,016	2,504	4,537	7,041
1907. . . .	2,543	22	...	...	...	...	...
— 1907-1908.	...	...	2,667	1,978	2,757	5,839	8,596
1908. . . .	2,123	1	...	...	...	...	...

(*) Russo-japanese war.

(1) It was in November 1871 that the first package of flowers intended for sale was sent from the Mediterranean coast to Paris. The invoice price was 4·50 francs (3*s.* 7 1/2 *d.*), and the carriage cost 3·65 (2*s.* 11 1/2 *d.*); total, 8·15 francs (6*s.* 6 1/2 *d.*). It was sold at the market for 84 francs (£3.7*s.* 2 1/2 *d.*), and this was the starting-point of this flower trade which has taken such an extension by now.

As regards the international traffic, the following table gives the imports into England and Germany; the figures are taken from the customs returns of those two countries :

YEAR.	England, value (in pounds sterling)				Germany, weight (in tons)			
	from France.	from Holland.	from other countries.	total.	from France.	from Italy.	from other countries.	total.
1900	125,229	5,496	1,117	131,842	...	...	...	...
1901	139,089	6,236	1,091	146,416	1,021	226	252	1,499
1902	158,883	7,253	1,053	167,189	1,330	401	323	2,054
1903	159,602	6,056	1,145	166,803	1,449	514	376	2,339
1904	144,521	5,676	644	150,841	1,752	552	393	2,702
1905	101,185	5,574	300	107,059	1,440	410	680	2,530
1906	128,184	7,573	346	129,093	1,903	561	449	2,913
1907	120,867	4,251	198	125,316	1,920	506	463	2,889

Thus in addition in the consumption of flowers also, which are an article of luxury, pure and simple, a nearly-certain index of the prosperity of a country, we again find the very characteristic progress of Germany which we already noticed in the case of perishables.

In England, under reserve however of any alteration in the system of valuation adopted by the customs, the imports dropped materially in 1905 and have not yet reached their former level.

In the case of this traffic, it is evident that the rates for carriage are but of secondary importance; however, on account of the extreme subdivision of the consignments they can nearly all benefit by the reduced home or foreign parcel post rates.

A common quick-freight tariff, No. 414, exists for flowers carried from the Riviera by the *trains de luxe* of the international Sleeping Car Company to Vienna, Oderberg, Warsaw, St. Petersburg and seventeen German towns; but according to the answer supplied by the Paris-Lyons-Mediterranean Railway this tariff is used but little.

In the ordinary course of practice, the international consignments are however not sent as postal parcels direct; most of them are sent from the points of origin to transit agents established at Petit-Croix and Cologne for Germany, and at Boulogne for England; these transit agents devote their whole attention to the prompt re-dispatch and conveyance of these packages to their ultimate destinations.

This is another example, in addition to that of the refrigerator vans, that in the case of traffic requiring special care, the public prefers to deal with special enterprises, in spite of greater cost, rather than with the official services of the railway administrations.

In the case of this essentially-delicate merchandize, quickness and care are in fact of paramount importance.

It is largely to an increase in this care and attention that the Italian State Railway attributes the considerable increase in the season 1907-1908 as compared with the season 1906-1907.

We can get a notion of the difficulty of this work if we consider that on certain days, the Paris-Lyons-Mediterranean Railway receives and loads up as many as 20,000 packages of flowers at its stations on the Mediterranean coast.

In 1908, the arrivals at Paris above-mentioned amounted to 86,400 packages in November and to 98,835 packages in December; the maximum on any one day was 5,100 packages on 23 December 1908.

In that same month of December, about 55,000 packages going to Germany passed through Petit-Croix and Cologne.

About the same number was received at Boulogne for transmission to England; as many as 6,000 have been received at London in one day.

In order to do this work, the Paris-Lyons-Mediterranean Railway runs every day a pick-up train which starts from Nice at 1 p. m. and arrives at Marseilles at 5:30 p. m., collecting at the intermediate stations the flowers which are handed in between noon and 2 p. m.

The consignments are placed as collected in specialized vans which at Marseilles are attached to the corresponding fast trains.

This special service makes it possible to deliver flowers, dispatched in the middle of the day from the Mediterranean coast, to the flower shops at Paris on the next day, between 11 a. m. and noon.

By this exceptional use of quick trains, the time required for the journey on the railway has been reduced; thus consignments from Nice, for instance, take 21 hours 15 minutes to Paris, 24 hours to Petit-Croix, 28 hours 20 minutes to Boulogne, 45 hours 43 minutes to Frankfort on the Maine, about 30 hours to London; and when the *trains de luxe* are used, 29 hours 16 minutes to Berlin and 70 hours 55 minutes to St. Petersburg.

This very important service is moreover carried out with the utmost regularity, and a Paris merchant was able to state that out of 35,000 packages sent to him in the winter 1907-1908, nine only failed to arrive.

Although through carriage is in question, without transhipment, and these packages tempt thieves less than articles of food, this result is none the less worthy of notice ; it proves at the same time that proper care has been devoted to the carriage itself, to the quality of the packing and the labelling, both by the railway and by the consignors.

Nota. — The annexes mentioned in this report are published in the *Bulletin of the Railway Congress*, No. 6, June (1st part) 1910, p. 2445.

SECTIONAL DISCUSSION

Meeting held on 11 July 1910 (morning).

MR. COLSON, IN THE CHAIR.

The President. (In French.) — I call upon Mr. Culp to give a summary of his report.

Mr. Culp, *reporter for all English-speaking countries.* — This report does not deal with the question of rates, which from the information obtained from replies received by your reporter, are regulated by commercial conditions, competition and the value of the service to the shippers and receivers, even where the Government authorities fix the maximum rates.

The report deals chiefly with measures to preserve the perishable traffic as nearly as practicable in its original condition even for distances as long as 3,200 miles and for shorter distances. It treats of methods of refrigeration, insulation, ventilation and of the heating of the cars. It furnishes information showing the variations of temperature under methods of refrigeration, insulation, ventilation and heating.

This report deals with the handling of all fresh meats and products of packing houses, with dairy products, such as butter, cheese and milk; poultry, various kinds of fruits and vegetables (sub-divided into highly perishable fruits and vegetables and ordinary perishable fruits and vegetables), with oranges, bananas, pine-apples, fish, and beer in wood. It deals with the methods employed for the preservation in transit of all these various articles to destination in their original conditions as nearly as practicable. It gives a description of the manner in which these articles are prepared for shipment, and shows the details and results of interesting and instructive experiments by the Department of Agriculture of the United States Government in connection with citrus fruits from California to the Atlantic Seaboard.

Reports have been received from the Argentine, England, India, South Africa, Australia and Mexico. Information has been obtained by your reporter from railways of the United States and from other sources in that country. The English-speaking managements, outside of the United States, have not given as complete information as to the refrigeration, insulation, ventilation and heating requirements in their respective countries as might be desired, and this has obliged the reporter

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to limit his suggestions to practices prevailing in the United States.

The reports from some of the countries named are very complete and elaborate as to methods of loading, description of cars, lists of perishable articles transported, and contain valuable information for which your reporter returns thanks.

Descriptions of various types of refrigerator cars and ventilated cars, and diagrams illustrating the results of the use of these cars in the development of meat, poultry, fruit, vegetable, milk and dairy product traffic in North America are shown. In some instances the increase in the traffic named is very striking.

The report gives descriptions of the kinds of cars and the practices of English-speaking managements of railways other than those in North America.

In the Argentine, the movements are for short distances, and existing facilities are felt to be adequate. No information is furnished as to the measure of refrigerator cars, methods of stowage, or rules for the general conduct of perishable traffic.

The English railways in addition to full description of cars used for the transportation of perishable traffic, give their rules and practices, and report that present facilities appear to be adequate for existing requirements, and no suggestions are offered by those railways looking to further improvements for the increase of the traffic.

Replies from India indicate that the managements of the Indian railways feel that for present demands, their traffic does not require the use of other than ventilated vans or waggons, handled on passenger train schedules, which is their present practice.

Replies from South Africa indicate satisfaction on the part of the shipping agents and the receiving public, from which the conclusion may be drawn that the subject of facilities has received, and is receiving, attention at the hands of those railway managements with the object of fully developing the traffic in perishable goods.

The Australian railways give descriptions and diagrams of refrigerator cars used, also information as to the encouragement of the perishable traffic by the government through the provision of cold storage depots, and by private firms also, and state that the carriers by concessions in rates on fertilizers and manures, are stimulating the production of perishable articles.

Reports from Mexican railways state that the railways use their own refrigerator cars, charge for ice at actual cost and for the actual weight of the load, but offer no suggestions for any change in their present methods and practice. Refrigerator cars are used chiefly for the transportation of beer. Pulque, which is a native vegetable liquor and highly perishable, is nevertheless shipped in cars which in their construction are similar to ordinary live stock cars in use in the United States and Canada.

When the data for this report were procured, arranged and published, the system of cooling fruits and vegetables in the car before the journey had begun (in other words pre-cooling fruit), may be said to have been in the experimental stage. Since that time, much progress in the matter of this system of pre-cooling has been made.

The intermittent vacuum principle or system (known in the United States as the

Sprague system) is referred to in the report, but improvements have since been made in that system, and it is in successful operation at two large fruit shipping markets on the Southern Pacific Railway.

Another system, that of forcing a current of air through the car, driving cold air in through one duct and drawing the warmer air out through another duct, until the car and its contents are properly cooled which is known as the "Gay system of pre-cooling", is in operation on the Atchison, Topeka & Santa Fe Railway. Both of these systems, so far as your reporter can learn from information and examination of the plants and by witnessing the operation of one of them, would satisfactorily provide for the delivery of fruit and vegetables and other perishables at destination over long distances in nearly, or quite, as good a condition as when loaded into cars.

An improvement in connection with the refrigerator car has likewise since this report was published, been devised. This is a collapsible ice tank or bunker, known as the "Bohn" Collapsible Tank Car. It has been installed on a number of cars on the Western railways in the United States. This tank when not in use may be moved to the top of the car and to the ends of the car and fastened there until it is desired to again use the tank, thus increasing the capacity of the car for ordinary freights, it is said 11 per cent for every time used, with an increase in the original cost of the car, including the device, of 10 per cent over the ordinary refrigerator car. This latter expense once made is of course made for the life of the car or of the device.

The report describes an apparatus for heating cars in which is oil used as fuel. Since the report, there have been at least three heaters invented using oil as the fuel, which, it is claimed, are all improvements on the apparatus described in the report. There has likewise been invented and put in use a charcoal heater, known as the "Baxter Heater", which is claimed by at least one very large system using it, to be superior to all the other heaters.

Descriptions, diagrams and photographs of the two systems of pre-cooling, the collapsible ice tank, and the four styles of heaters are in the possession of the reporter, who will, if the Section or the Congress think it of sufficient importance, be pleased to furnish them to the Congress, or make a supplementary report containing information respecting the same. (See appendix.)

The following are the conclusions deducible from my report :

1° That it is essential that the carriers should do whatever may be reasonable to aim at delivering the perishable traffic at destination in good condition, and to accomplish this they should endeavour to have, especially over long distances, thorough expulsion of heat from all highly perishable animal and vegetables substances, exc ept bananas and pine-appels, before shipment;

2° They should aid in the dissemination among producers and handlers of all classes of perishables, of information, of suggestions of improvement in methods of preparation, packing, hours for delivery to the carriers, and reasonable provisions against all possible contingencies of transportation and delivery to the consumer ;

3° That the railways should provide, as far as may be reasonable, the most improved class of vehicles and methods of refrigeration, insulation, ventilation and heating. The tendency

in some countries, notably in the United States, through either governmental requirement or commercial competition, is to require the railways to do this.

Under existing laws in the United States, railways are required to provide refrigeration as a part of the transportation, and while it is at present chiefly done by private companies through arrangement with the railways, the responsibility for furnishing these items of transportation rests with the railways.

If means are adopted to preserve the perishable traffic in transit, the making of reduced rates to stimulate this traffic is unnecessary, and the necessity for moving the trains containing these perishable articles at higher speed becomes of secondary importance, enabling the carriers to reduce the cost or prevent its increase through higher speed, and lessening the grounds for complaint by shippers and receivers as to the condition of perishable goods on delivery at the point of destination.

Mr. Bloch, *reporter for all countries except those using the English language.* (In French.) — The question runs as follows : *Suitable measures for developing the traffic in perishables packing, refrigerator vans, appliances for keeping temperature constant, etc.*

The question may be understood in two different ways : either as including all the questions involved in this particular traffic, or else as limited to the points specially mentioned, namely packing and rolling stock.

In the latter case, the limited results observed in countries other than those using the English language, would have led to drawing up a report of hardly any size.

Therefore it seemed to me more in agreement with the real intentions of the Permanent Commission to take the wider interpretation and study this traffic as a whole. All the more so as Mr. Culp's report, which for many of us is a sort of revelation, gives very complete and interesting details about refrigeration.

My report is divided into several chapters, the titles of which indicate sufficiently the contents : I. Traffic. — II. Tariffs and conditions of liability. — III. Trains and accelerations. — IV. Means of conveyance, refrigerator vans, constant-temperature vans, etc. — V. Settlement of claims. — VI. Various measures, packing. — VII. Propaganda for the development or improvement of production.

Three appendices, which I will not deal with in this summary, consider more especially and investigate, as examples of particular traffics, the cases of milk, sea-fish and fresh-cut flowers.

I. *Traffic.* — This chapter, compiled with the help of the custom-house statistics, studies more especially the international exchanges, that is to say, one of the chief fields of activity of railways.

Examining in succession the traffics of exporting countries and those of importing countries, it deals, chiefly graphically, with the following classes of the more important perishables : butter, eggs, fresh meat, poultry and game, fish and shell-fish, fresh vegetables, fresh fruit.

Summing up the detailed analysis of these different traffics, it is shown that they have grown rapidly under the influence of the development of the prosperity, of the growth of wealth and of population and of the greater facilities given by the railways.

This trade in perishables is still greatest in England; its progress in Germany is also considerable. Its development is specially marked in the case of such produce as fruit and vegetables, in which the outputs of the different countries are to some extent supplementary, and the importing of which accordingly does not meet with any serious opposition.

The same is the case with farm produce, butter and eggs; the growing need for these in industrial districts exceeds the amounts that can be produced in those districts and makes it necessary to go further and further afield.

In the cases of sea fish and of meat, on the other hand, attempts are made nearly everywhere to protect home produce; moreover, especially in the case of meat and of poultry, the risks of conveyance are greater and the producer is not anxious to expose these expensive goods to the risks of long journeys, in rolling stock not fully equipped for the purpose.

All this traffic in perishables, the importance of which is shown in the report, its progress and its tendencies, depend in the long run chiefly on the care bestowed on such transport.

II. *Tariffs, rates and conditions of liability.* — The report shows that the various administrations have generally taken two different points of view. Some, taking into consideration the difficulties of conveying perishables and the extent of the risks run, offer the public reduced rates in exchange for reduced liability; others, in France especially, assume that the value of those perishables is due nearly entirely to the conveyance itself, and accept more limited liability while, on the other hand, keeping the rates sometimes a little high.

In order to decide between these two systems, there is a *judge*, namely the trade itself. That, at least in France and until quite lately, does not ask for reductions in rates, but lays stress on speed and regularity.

There is a *criterium*, namely the results. Now French trade does not play a poor part in the international markets.

Independently of these considerations other reasons, the geographical position for instance, may influence railway rates.

After these general considerations, the report successively considers in detail the tariffs of the different countries, both the home tariffs and the export or international tariffs.

It sets forth more especially the essential difference between the French tariffs, which classify the goods according to their approximate value, applying rates which decrease with the value, and the simpler tariffs of other countries where there is most frequently only one class, sometimes with a few exceptions, as in Italy, in the case of certain articles which are carried at reduced rates.

As regards French tariffs, the report draws special attention to the clause concerning the "specially-designated" trains, which defines the liability of railways in case of delay of trains actually carrying the perishables, and also to a special clause that it should be desirable to give the public the right, in the case of international traffic of this kind, to ask for *the quickest route*, paying of course the rates charged for the distance reckoned for that route.

The chapter concludes with a summary investigation of the influence of reduced tariffs on the development of the traffic;

an analysis of the results of the important general reductions made in France in 1892, in the case of all quick-freight goods and of perishables in particular; the somewhat doubtful results of the 50 per-cent reduction introduced in 1907 in the tariffs for meat in Germany and Austria. All these and other facts lead to the conclusion that general reductions in the rates made *a priori* can only give mediocre or poor results.

At the end of the chapter, the question of the return of empty packages in the different countries is dealt with, and the complications which arise in international traffic in consequence of variations in the exchange.

III. *Carriage. Trains used. Acceleration.* — Subject to the reservation that most of the administrations, except in France, do not enter into any real engagement to carry goods in a given time, all try to reduce this time as much as possible.

Regulations or special provisions for carrying perishables exist in sundry countries. In Italy, in particular, there is a very good organization of special trains for carrying perishables as well as for the conveyance of full wagon loads of these goods.

As a special example worth imitating, I may mention the sending of the way-bill in duplicate, one copy being carried in the wagon containing the goods, the other being used, as in the usual practice, for different operations *en route*.

At the end of the chapter, there is a table compiled from official documents of the various administrations, which shows the mean inclusive speeds of such transports in different countries on a certain number of lines, and illustrates the efforts made in France from this point of view.

IV. *Means of conveyance (special refrigerator vans, etc.).* — Fixed or movable equipment in wagons of ordinary type (shelves, trays, movable cross-beams with meat hooks, etc.) is only used to a rather limited extent; is it either owned by the railways themselves, who place it at the disposal of traders, or else it is owned by the traders.

Except in special cases, the system of carrying this equipment free forwards and backwards seems unfair from the point of view of other traders using the ordinary means, and consequently compelled to pay for the carriage of their packing, which has to be stronger and consequently heavier.

Some of the railways, in particular the Italian State Railway, the Paris-Lyons-Mediterranean Railway and the Orleans Railway, use for this traffic wagons with double walls with a layer of air in between, ventilated by means of openings at the lower and upper parts of the end and side faces.

The Italian State Railway has a type ventilated by means of covered openings extending over the whole height, at the two ends of the side walls, and these openings can be closed by sliding doors.

But do not these large openings allow dust to enter and damage the goods? It would be interesting to have information about this point or about the means employed for preventing this.

Owing to the difficulties which result from the differences of language, of regulations, of custom-houses, etc., the use of refrigerator vans is practically limited to the home traffic of the different countries,

and the total stock of such wagons, in Europe, excluding Russia, does not exceed 1,100 wagons.

That is a very small number as compared with the 60,000 wagons of the United States.

Only in Russia and Siberia, where this traffic is facilitated as in North America, by being under one rule, is this traffic quickly becoming more and more important in the case of butter.

This conclusive result seems to show that the only way to develop this very desirable refrigerator-van traffic is for the different countries in Europe to adopt uniform and common regulations.

A basis for useful and efficacious work from this point of view is to be found in quick-freight tariff 121, which has lately come into force after long investigations, made by the French railways, relating to this special traffic.

In this question of refrigeration, the chief interest now seems to be in the precooling processes which Mr. Culp has mentioned. A trial of them will shortly be made at Château-Renard (Bouches-du-Rhône) by the French section of the International Refrigerator Association.

Mr. Culp, in his report, has given very interesting information which is confirmed by a note sent to me by Mr. Pike, secretary of the Refrigerator Service Association, Chicago.

The resulting tendency is to simplify the cooling operations *en route* and to replace them by cooling at the starting-point. In this way, a very considerable saving has been effected in ice, and there is hope that methods will be found to eliminate the use of ice altogether in the case of short-distance traffic.

V. *Claims.* — This chapter sets forth more especially the different points of view in the different countries : resistance to the claims of the public in the countries with a State system and a strong administration ; augmentation, on the other hand, of the liability of railways in the countries where there are chiefly company railways.

The legal times of delivery in France, Italy and Germany are compared and note is taken of the greater liabilities undertaken of late by the French railways.

As regards damage, the report sets forth the difficulties which cause disputes in connection with waste due to the nature of the goods and with the diversity of the rules applied in determining that waste.

Seeing the growing importance of the international traffic in perishables, the summary rules laid down in article 32 of the Berne International Convention and in paragraph 8 of the executory provisions have become insufficient; the wish is expressed that a well co-ordinated list, taking into account the nature of the goods, the size of the consignments, the length of the journey and the season, should be established, so as to serve as a guide and support to the railway administrations.

VI. *Various measures. Packing.* — This chapter is divided into two parts, concerning respectively the measures to be taken by the railway themselves and those to be demanded from the public.

The former include in particular the labelling of the packages and wagons, which everywhere are made the object of special recommendations in the case of this urgent traffic.

The correct transmission of the papers

is also specially necessary in the case of this traffic, particularly in the case of international traffic, for any delay in the papers, preventing or delaying delivery on arrival, frequently causes trouble.

The practice of the Italian State Railway, to place in the wagons duplicates of the way-bills, is to be recommended. The railway delivering the consignments might also be asked to exercise their discretion, in the case of such a delay, and to deliver the consignments to well-known traders who show sufficiently clearly that they are entitled to them.

As regards the public, proper labelling is demanded and also proper packing, so as to protect the goods both against damage and against theft.

In this case, one recognizes the difference between the State systems, on the one hand, sufficiently armed with their general regulations, and whose demands meet with no difficulties from a better-disciplined public and, on the other hand, the private companies, less protected, who are led to specify in detail, in the conditions of their tariffs, the chief rules which are to be observed by consignors in the labelling and packing of their consignments.

VII. *Propaganda of the railways for the development or improvement of production.* — In all countries, except in France, the care for such propaganda is left to the authorities and to the agricultural societies; in France, the Paris-Lyons-Mediterranean Railway and the Orleans Railway have shown great activity in addition to that of the Minister of agriculture and the farmers' societies.

Dr. Wiedemann, *secretary-reporter*. (In French.) — Mr. Bloch, reporter, proposes some conclusions which differ from those given in the printed report. I have just been informed that they will not be read out, as it is desired that they should first be printed in the *Journal de la session*.

Gentlemen, with the permission of the President, I propose to make two short statements to supplement the very interesting and clear report of Mr. Bloch, concerning the difference of principle specified in the report, in two places, as existing between privately-owned railways and State railways.

In chapter V, which treats of claims, Mr. Bloch takes a first group of countries, with strong governments, where most of the railway systems are operated by the State, and where the claims of the public meet resistance; then he takes a second group, including principally the Latin countries, where the railways are still chiefly in the hands of private companies and where laws and precedents enhance the liabilities of those companies.

In Switzerland, the *legislation* concerning the liability of the railways in cases of delay, loss and damage has remained the same in principle now there are State railways as when these were privately-owned railways. It applies at present alike to the State railway and to private railways. Similarly, the practice of the claims departments, both as regards the home services and the international services, has in no way altered the position of claimants since the State took over the railways. The law department of the general administration of the Swiss Federal Railway, in particular, which has to deal with the application of the International convention for the carriage of

goods on railways, tries, by the equitable settlement of claims, to establish good relations with the public, because it considers it undignified for the State to settle these claims merely from the point of view of self-interest, and because it has been found that traders are then less likely to make claims in cases of minor importance. Nor has Swiss *jurisprudence* become modified since the nationalization of the principal railways. It is, however, observed, at least in French Switzerland, that jurisprudence has become slightly more strict towards the Federal Railway than it was in the case of the private companies.

In the sixth chapter, which deals with miscellaneous measures, packing, etc., the reporter again states that one finds a difference beween State railways and private companies, as regards the labelling and packing of consignments. The State railways are said to be protected by the general regulations laid down by law, the application of which is not opposed by the public. The company railways, the report alleges, are much less protected by the State, and are consequently compelled to issue rules detailing the obligations of consignors as regards labelling and packing.

I consider that that remark also does not apply to Switzerland. Article 11 of the act of nationalization stipulates in fact that the federal legislation concerning railways is applicable to the Swiss Federal Railway, in so far as that application is compatible with the provisions of the said law. The latter is accordingly under the same laws as the company railways. The same is the case from the material point of view : the Swiss traffic regulations and the general provisions of the Swiss law concerning the labelling and packing of merchandise, are obligatory as regards the Federal Railway as much as regards the companies.

It seems to follow from these two remarks that in Switzerland at least the relative position of the State and of the company railways does not show such differences, as regards perishables, as certain parts of Mr. Bloch's report might lead us to believe. Matters must be similar in other countries, and it may be assumed that the State administrations and the company administrations can, on the basis of the conclusions proposed, cooperate, with success, in improving the conditions of carriage of perishables both as regards home traffic and as regards international traffic. It is all the more desirable to arrive at this result, as it is not merely a question of the carriage of *articles de luxe*, but also of really necessary articles (milk, meat, eggs, etc.) intended for poorer people.

The obligation of bringing these articles to their place of delivery in good condition is hence not only a question of increasing the revenue of railways, but also an important proposition from the point of view of public health; and this offers, to all the parties concerned, a field of activity capable of giving much satisfaction.

Mr. Lüttke, Prussian State Railway. (In German.) — In the first place — and I do so with much pleasure — I wish to compliment Mr. Bloch on the very great and frequently admirable care with which his report has been worked out; I will also not criticize it by noting the slight inac-

curacies it contains in connection with the German tariffs and regulations.

The report deals largely with the state of affairs existing in Germany, and I will therefore allow myself to explain, in connection with what is stated in the report, the point of view of the German administrations.

I think the report lays too much stress on the importance of the guarantees given by the railways as regards the speed of the transport, and, on the other hand, it fails to recognize the full importance of cheap rates for certain kinds of perishables, as far as Germany is concerned. The German public, taking it altogether, wishes to have a good transport service at moderate rates. It must be remarked that most of the perishables which are conveyed in that country are generally not of high value, while France exports articles of high value and very perishable (for instance, flowers and grapes). There is also the difference of climate. The German railways, State railways, have, as regards their smaller traders, the duty of making moderate rates for articles of food. The German public, the great majority of it, attaches much greater importance to cheapness as well as to quickness and regularity of transport, than to any greater guarantee of a very short time of delivery. Consignors who wish for such a guarantee must pay the higher rates fixed for express packages. In these cases, the German railways guarantee delivery within a very short time. But most of these goods cannot stand such high rates. Such goods are carried in large quantities. Frankfort on the Main for instance receives and dispatches every day about twenty full quick-freight trains, chiefly loaded with articles of food. It would be absolutely impossible to carry these articles by passenger trains only.

What is considered most important in Germany, I repeat it, is that the perishables should be carried *with great regularity* and with sufficient speed, so that any delays which occur, not as compared with specified times for delivery, but as compared with the shorter times which the public knows by experience, are very rare exceptions. With this object in view, a special service has been in existence for many years. Following the example of Prussia, all the German State railways have now created transport departments, who see that all slow-freight and quick-freight consignments are carried with regularity and with the greatest speed possible, and who look after connections. This department must not be confounded with that charged with drawing up the time-tables; the latter is quite distinct. Excellent results are obtained with this system in Germany and it may be asserted that the public does not ask for greater guarantees, as it knows by experience that the times are sufficiently short and are kept to in most cases.

In order to give an instance of the time within which such transports are affected (it is not exceptionally short, nor is it particularly long), the carriage of ordinary quick-freight consignments, most of which are carried at slow freight rates, only takes twenty-four hours from Frankfort on the Main to Berlin, a distance of 540 kilometres (335 miles). That the cheapness of the rates can contribute largely to the growth of the perishables traffic is also proved by the 1907 tariff for fresh meat, which, according to the report, only gave

mediocre results. I must remark that the reporter, when he drew up his report, could not have had the most recent figures before him; for, thanks to this tariff, the traffic in meat in Prussia increased from 32,000 tons in 1906 (that is, before the tariff was introduced) to 58,000 tons in 1910, and so has nearly doubled. Similarly, from the economical point of view, the adoption of this tariff was not a mistake. The German chambers of commerce are in fact of opinion that it prevented a further rise in the price of meat.

As regards rolling stock, I wish to add a few words to what is stated in the report. The Prussian-Hessian State Raailway owns a large number of wagons equipped, for this traffic, with fixed or movable boards. In particular, good results have been obtained with wagons equipped with hinged flaps which can be folded back against the walls and are arranged in several stories, so that the same wagon can successively be used for fruit, for milk and for other perishables, and also for all other goods.

These special wagons are, however, not placed, in Germany, at the disposal of those who send full wagon-loads, and who in fact hardly ask for them, for such consignors have their own wagons and see themselves to the proper regulation of the temperature, by means of ice or movable stoves, especially in the case of transports going abroad.

On the other hand, the Prussian railways have for some time been running refrigerator vans, in the interest of smaller traders. These vans run regularly every day, on the trunk lines, in certain quick-freight trains. The same rolling stock is used in winter, and it is equipped with steam-heating apparatus or stoves. Such vans run between Berlin and Frankfort on the Main, between Berlin and Hamburg, between Cologne and Frankfort on the Main, and on other important lines. Every quick-freight train here includes a wagon which is heated in winter, and cooled in summer, in which small packages can be shipped. It is self-evident that these wagons can also be used for international traffic, for carrying small quick-freight packages.

Mr. Elsner, ministry of public works, Germany. (In German.) — Gentlemen, allow me in my turn to make a few short remarks about the two reports which I consider extremely interesting; I wish more especially to say a few words about Mr. Bloch's report.

This reporter criticizes, from the point of view of equity, the fact that in Germany for instance — there are also other countries — the railway administrations do not pay any hire for the use of private wagons. I may remark, as against this, that in Germany private wagons, which run empty, have nothing to pay. That is a favour which in my opinion is at least equivalent to that granted by certain railways, the French companies for instance, who pay hire for the use of private wagons.

In the second place, it is claimed that in Germany the rules regarding liability, and especially those regarding compensation for delay in delivery, are more advantageous to the railways, and consequently less advantageous to the public, than those in force in the international service. That is not the case. In Germany every care is taken, and the higher authorities themselves see to it, that the

home traffic should not be treated less favourably than the international traffic. There is no exception to this principle.

The only instance quoted by the reporter in support of his statement, is paragraph 94 of the German traffic regulations, together with article 40 of the International convention for the carriage of goods on railways.

It must be admitted that calculating the time of delivery by tenths is more favourable to the consignor than calculating it by the complete day, as specified in the German regulations. But, on the other hand, it must not be forgotten that the German regulations give compensation for exceeding the time for delivery, not only when no damage has been proved, but also when there has been no damage. The railways hence cannot raise the defence, sometimes very troublesome for the consignor and accepted by many courts of law, that no damage has been caused by the delayed delivery.

Moreover, under paragraph 94 of the same regulations, the compensation for delay in the delivery can be added to that for loss or damage of the goods.

To sum up, my opinion is, that the public is no worse off under the German regulations than under those of the international convention.

Moreover, I think that the provisions of the latter, at which I have had the honour of collaborating during many years, are quite equitable, and equally protect both the consignor and the railway.

Next I wish to say a work about the conclusions enunciated in Mr. Bloch's report. I know well that the reporter intends to present them to us tomorrow in a new shape; but throughout his report we find the assertion that the cost of the carriage — the tariffs are evidently meant — is only of secondary importance in the case of perishables. I cannot agree with this opinion, at least not in this general form. It is possible that it may be true as regards articles of great value, such as flowers, early vegetables, etc., which form in France the greater part of this traffic. On the other hand, it cannot be asserted, and this has already been remarked, that in the case of articles of smaller value, the cost of the carriage, namely the rates, only play a secondary part. On the contrary the public, especially the poorer people in large towns, have great interest in having as cheap rates as possible for such goods, for milk for instance. It is self-evident that the speed and the regularity of the transport must not be sacrificed in order to obtain reduced rates.

Hence, I desire to amend in the following way the conclusions given in Mr. Bloch's report, the first three clauses of which I wish to retain.

The fourth clause should in my opinion run as follows :

" Rather it must be a strife of emulation, in which besides the qualities peculiar to the producer : selection, preparation, condition of the produce, the success will depend in the first place on the care devoted to the carriage, on the speed above all, on the use of suitable packing and on the guarantees given to the consignors by virtue of the conditions of the tariffs. The amount charged for the carriage (rates) only plays a secondary part, as long as merchandise of high value is concerned. The railways will accordingly do well, both in their own interest as well

as in that of its poorer customers, to devote particular attention to this question."

The conclusions contained in the American report can be accepted with some slight modifications, for in America, and probably also in Russia, particularly in Siberia, the conditions are quite different owing to the enormous distances the goods are carried.

The President. (In French.) — I propose to you to continue this discussion this afternoon; but as the Permanent Commission meets at 2 p. m., I have been requested not to start the sectional meeting before 3 p. m.

On the other hand, several members have asked that the conclusions should be printed before they are put to the vote; we could finish the discussion and proceed to vote the conclusions on Tuesday morning. (*Signs of approval.*)

It is accordingly understood that the discussion will be resumed at 3 p. m. this afternoon and that the vote on the conclusions will be taken on Tuesday morning.

Meeting held on 11 July, 1910 (afternoon).

The President. (In French.) — Mr. Pichler von Deeben will now address the meeting.

Mr. Pichler von Deeben, Austrian State Railway. (In German.) — While congratulating the reporter on the very interesting and complete report he has presented, I think I must support the remarks made by the delegates of the Swiss and the German railways. There can be no question of difference of treatment between State railways and the railways of private companies as regards carriage and packing regulations.

I will be brief; it is enough if I mention that as regards all the points here in question, the Austrian traffic regulations agree word for word with the German traffic regulations. Moreover, the packing regulations are on the whole the same. As regards international traffic, the regulations in force are those of the international convention.

The question of the tariffs applying to perishables which are of importance to the majority of the population in Austria also does not play a secondary part, and thus I fully approve the criticisms made by Mr. Elsner and his proposed amendment to Mr. Bloch's conclusions.

Mr. Silva-Freire, ministry of public works, commerce and agriculture, Brazil. (In French.) — The reports presented to us form the elements of an investigation of a kind enabling us to do useful work, taking as our basis the long practice in the United States.

This question of the perishables traffic has been treated from the point of view of the European railways by Mr. Bloch in all its details; and I only wish to address the meeting in order to draw your attention to the question of the carriage of tropical fruit, especially bananas and pineapples.

The report records that in the United States in 1903, the import traffic alone amounted to three milliards of bananas, and this traffic has increased considerably since.

The banana is found in abundance in tropical countries and it is only the question of transport which hinders the growth of the consumption of that fruit in Europe.

The example of what has happened in the United States shows what results can be attained in a short time, if the interests of the railways and those of the public march hand in hand.

It has to be remembered that there is a season of the year when fresh fruit is lacking in Europe, and if bananas could be carried cheaply as far as the centre of Europe, the railway would have a new traffic, and consequently new resources, and the new trade which would result in consequence would not clash with the trade in European fruit, seeing that the times at which fruit ripens in Europe and in South America are widely different.

It would be easy, if an agreement were made about the carriage of tropical fruit, to find new markets for the latter with considerable profit. It seems to me that from the point of view of railways, that it is a question worth considering.

For several years, we have been finding that transport by refrigerator vans is taking a great development, and one may say that it will develop still further if better-designed vans become available.

When the European railways are in possession of a large quantity of such rolling stock, it is probable that that rolling stock will not be utilized sufficiently at the times when no fruit is gathered in Europe.

That will be the time for using these refrigerator vans for the carriage of tropical fruit.

An agreement from this point of view would be desirable between the carrying companies, and even the governments should help the development of the consumption of bananas, which are whole some fruit.

In the United States, a considerable part of the population in the south lives on bananas. In Brazil, they are also largely consumed; it is a fruit which is recommended by physicians.

The Brazilian government considers this question of exporting tropical fruit a very important one, and has come to an agreement with several shipping companies which on their side propose to help the government and promote the export of tropical fruit.

A trial has been made, and it is stated that a good result can only be arrived at by means of an agreement between shipping companies and railways.

The ports in the south of Europe are more especially those which are able to develop this trade.

You now see how this trade might be extended by means of an agreement which would not only benefit carrying companies, but also at the same time serve economic interests.

The phenomena we have observed in the United States might also be produced in Europe, if we remember that the fruit of the countries in the southern hemisphere can replace in Europe the fresh fruit just at a time when it is not available.

Mr. Timonoff, ministry of ways of

communication, Russia. (In French.) — Mr. Bloch's very interesting report is of special interest to the delegates from my country, for it records the great development which the perishables traffic has made in Russia.

Mr. Bloch does us honour in pointing out that the different special measures taken in Russia for the carriage of Siberian butter have given the desired results and that the way in which this traffic is conducted can be taken as a model.

I should, however, like to be allowed to correct some inaccuracies in the report, and this seems to me all the more important as the perishables traffic in Russia is continually growing.

In order to give you an idea of this, I need only give you some figures. According to a careful investigation made by Mr. Pétroff, the quantity of articles of food, such as fruit and vegetables, carried in 1906, amounted to 155 million poods (2,498,861 English tons), representing a value of 330 million roubles, that is to say, about 40 million pounds.

These figures are enough to show that these articles of food are not exclusively intended for the rich, but also for the middle and to a certain extent also for the poorer classes.

This traffic is in part international traffic, for a great quantity of Russian butter goes abroad, and certain countries, such as Denmark and England, have a particular interest that these goods should be carried under good conditions.

The railway regulations concerning carriage generally and especially the carriage of perishables are extremely strict in Russia. In fact, while the ordinary slow-freight consignments are carried at the speed of 150 versts (100 miles) per twenty-four hours, perishables are carried at that of 400 versts (265 miles).

The regulations are applied with strictness. If the perishables have deteriorated, their price is repaid by the railway and if there is delay, the companies pay compensation.

The government does not favour the railways; on the contrary, it is those who are interested in the consignments, the owners of the merchandise, who are favoured.

In case of any dispute before the courts of law, the railways have to prove that they are not in the wrong, and the courts generally have a tendency to be on the side of the public rather than on the side of the railway.

No difference is made between the railways operated by companies and those operated by the State; both of them are treated in the same way.

The tariffs for the carriage of perishables have been considered with great care both by the railway companies and by the Russian ministry. Attempts were made to favour this long-distance traffic, by applying the principle that traffic should not pay more than it can bear, and thus the result has been arrived at of carrying fruit as quick freight while only charging slow-freight rates.

The sole object of my observations is to show that in Russia the perishables traffic is operated in a way which evidently represents some improvement and that there is reason to believe that if we proceed further in the same direction, we shall succeed in making this traffic grow, which is not only national, but also tends more and more to become international.

Mr. Bloch, *reporter*. (In French.) — I begin by thanking the speakers for the praise they have bestowed on my work. I have tried to contribute my stone towards our common edifice and I am glad I have succeeded in doing it. I still have to answer several criticisms and to clear up a misunderstanding. I never said that in the countries where there are both railways operated by the State and others operated by companies, the powers that be apply different rules. On the contrary, I am convinced that in all the States represented here, everybody has equal justice.

Only in the countries where the railways are chiefly State railways, the regulations contain as a rule conditions which are stricter as regards the public and easier as regards the railways. The German regulations and the Austrian regulations have been mentioned; I think that the difference is a minimum and that the States in central Europe have in reality regulations very similar to those of the Berne International Convention.

In France, on the contrary, we of the railways would be very happy to benefit by such a regime.

Mr. Lüttke has reproached me with laying too much stress on the liability and too little on the effect produced by lowering the rates.

He thinks that the rates of carriage may have a considerable influence on the cost of articles of food consumed by the public, and that it may be advisable to apply reduced rates to the articles of more ordinary quality.

I wish to inform you that in France also we have done much in the way of such reductions in the case of ordinary articles of food.

I now will answer Mr. Lüttke, who has referred to what I have said regarding the effects of the 50-per-cent reduction in the fresh-meat tariff in Germany at a critical period.

I knew nothing of this reduction and I had no idea of the existence of this tariff and I was only informed of it by the answers received to the questions I addressed to the different railway administrations.

Question II-*b*, of the list of questions addressed to the different railway administrations was worded as follows : *Have reductions of any importance been recently made in the tariffs? To what extent? With what object? With what conditions? What result have they given?*

Two or three administrations of German and Austrian railways stated, in answer to this question, that the 50-per-cent reduction in the meat tariff had given no result.

The Austrian State Railway even added that this reduction in the rates, which came into force in 1907 I think, was done away with three months later, on account of the insignificant results obtained.

It is possible that the fresh-meat traffic has taken a certain development since, but what I can definitely state, is that in my report I have in no way modified the bearing of the information supplied to me.

In conclusion, I may mention that in the first paragraph of the conclusions we propose to the section, we consider the rates for perishables intended for popular consumption and we recognize that it can be advantageous, in certain cases, to allow material reductions in the rates.

The President. (In French.)—Mr. Haines, who has put his name down, is not present, and as nobody else wishes to speak, I propose to adjourn the meeting.

It is understood that we meet on Thursday to discuss and put to the vote the conclusions which by then will have been printed in three languages. (*Approval.*)

Meeting held on 14 July 1910 (morning).

The President. (In French.) — We resume the discussion of question XVI : " Perishable goods."

Mr. Bloch will now address the meeting and read out the new proposed conclusions which he has drawn up.

Mr. Bloch, *reporter.* (In French.) — Gentlemen, the conclusions which I have the honour of bringing before you differ appreciably from those I have previously proposed. I have modified the latter to some extent, taking into consideration the remarks made during our last meeting, in particular by our German colleagues.

This is the new draft :

" The Congress records the great and general increase in the perishable-goods traffic, which is largely due to the special care which all railways devote to these very delicate goods.

" The discussion on this question led to the following conclusions :

" 1° Although carriage rates can eventually appreciably influence the traffic in cheaper perishable goods chiefly intended for popular consumption, yet as regards the more expensive classes, and particularly those of international commerce, the development of the traffic depends chiefly on the care taken to ensure that such goods arrive at their destination in the best possible condition. The railways could eventually give guarantees concerning this care under strictly-defined conditions and within strictly-defined limits.

" 2° A very important part of this care is however a matter for the producers, who should deliver their produce to the railways in the best possible condition as regards selection, preparation, condition, etc.; in this connection it may be useful for railway administrations to disseminate among producers information regarding the kinds of fruit in demand at the different markets, the best methods of preparation, packing, etc.

" 3° As regards the acceleration of consignments, it is desirable that appropriate rates or special rules should be inserted in the regulations of international conventions, so as to give consignors the option of choosing the routes giving them the quickest transit rather than the shorter routes, the consignments being charged at the rates fixed for the routes asked for.

" 4° Although transport with refrigeration or with special ventilation or with heating can be undertaken successfully by railway administrations in very large countries, such as the United States of America or Russia (including Siberia), yet conditions are far from being the same in the case of States of much

*

smaller area, such as those in Europe, for instance.

" In the case of transport in the interior of these countries, on account of the short distance and the quickness of transit, the use of these improved methods, even though it can always be recommended, has not, to anything like the same extent, the same character of necessity.

" Their use appears to be greater in the case of international traffic, generally over greater distances; and it is desirable that the administrations of the European railways should agree to common regulations in order to give such shipments in refrigerator vans all the facilities compatible with the requirements of their services.

" Moreover, owing to the very variable and special attention these shipments require during their whole transit, and owing to the participation of a number of administrations, it appears probable, at least in international traffic, that the operation of refrigerator vans would be managed under better conditions by private persons, working for this purpose by agreement with the various administrations cercerned.

" 5° On account of the difficulties caused by the return of empties, it would be of interest, both to the railways and to the future of the traffic, to promote the development of the custom of using packages which are not returned, known as " *non-returnable empties.*"

" On the other hand, it seems advisable to specify in the tariffs the conditions which packages in general must satisfy, so as to protect the goods as far as possible against thefts and the normal risks of carriage.

" 6° In order to prevent or diminish difficulties with consignees, resulting from waste ascertained on delivery in the case of goods specially liable to such waste, it would be desirable to supplement the summary rules of article 32 of the Berne convention and of paragraph 8 of the executory provisions, by more complete directions suited to the nature and the conditions of this particular traffic. »

Mr. Pichler von Deeben. (In German.) — It was only immediately before the meeting that the new proposed conclusions were distributed; there are six conclusions, all very important, and requiring careful consideration. It is hardly possible for me, and the same no doubt applies to other members, to check the agreement of the German text with the French text, and above all to grasp the full bearing of those conclusions. I feel sure that an hour or half an hour would suffice for this examination and I accordingly request you to give us the time necessary to form our opinions.

The President. (In French.) — We have before us a motion for adjournment. I must remark that the text of the conclusions just handed to you was sent to the printers the day before yesterday and we certainly hoped it would appear in the *Journal* published yesterday morning.

But finding this was not the case, we had off-prints made which were placed in the boxes. As our German colleagues think that they have not had time to grasp the full bearing of the new proposed conclusions, I think it would be advisable, in their interest, to adjourn the meeting for one hour.

Mr. Pichler von Deeben. (In German.) —

That time is long enough for us; I wish to thank the President, in the name of my colleagues as well as in my own, for kindly granting our request.

Mr. Elsner. (In German.) — In my opinion, the proposed conclusions which have just been distributed give rise to many objections, both as regards form and contents. I will mention the last paragraph, which is particularly important. It is a question of expressing the wish that paragraph 32 of the Berne Convention, which corresponds to the prescriptions of the codes of commerce of most of the countries belonging to the convention, and to their home regulations, should be modified. I therefore here declare, that I intend later on to bring forward again the proposal I made Monday last, of retaining the conclusions again in Mr. Bloch's printed report, with the amendment I proposed at the last meeting.

In my opinion, if we start the examination of new projects, it will take several days before we are finished, so important do these conclusions seem to me as to contents, and so difficult as to form.

The President. (In French.) — Is the meeting of opinion that it should adjourn for an hour? (*Yes, yes.*)

— The meeting is adjourned and will meet again at 11 a. m.

The President. (In French.) — Gentlemen, our German colleagues have not yet attended the meeting, but as Colonel Haines wishes to make a communication to the meeting, I propose that he should be heard at once. (*Approval.*)

Colonel Haines, United States Government. — I desire to express my thanks for this opportunity to offer some remarks as to the transportation of perishable products; and I shall address myself principally to the railway administrations of Continental Europe.

The official positions which I have occupied in the United States enabled me to gain much experience in this matter and, during a residence for several years on the Riviera, I have observed with surprise the apparent lack of interest in the development of traffic of this character in a region whose products are so well suited for it. Yet the railway administrations of France and of Italy, of Switzerland and of Germany, should draw substantial benefits from such traffic; for I believe it to be possible by cooperation among them to arrive at results similar to those that have been realized in the United States, where the revenue from the traffic in perishable products now amounts to many millions of dollars.

The report of Mr. Culp, whose competence in this matter is generally recognized with us, is replete with valuable information. I will refer to two of his principal conclusions :

1° The thorough expulsion of all heat from highly perishable animal and vegetable substances, before shipment;

2° The dissemination, among producers and handlers of all classes of perishables, of any and all suggestions of improvement in methods of preparation, packing, hours for delivery to carrier, and reasonable provisions against possible contingencies of transportation and delivery to consumer.

I admit that the European railway managements cannot make use of refrigerator

cars of the character that has been specially adapted to the long distances over which this traffic is conducted in the United States. The freight cars in the European service might however be better utilized in this traffic if provision were made for the reduction of the heat inherent in perishable products before their transmission. By this precaution, the development of the germs of fermentation is arrested and the traffic is made more remunerative to the producers and to the railway lines.

In the United States, this service is performed by private enterprises, which employ their own plant in refrigerator cars and in cold storage depositories.

In the ordinary refrigerator car service, the packages of perishable products are loaded into the cars with all their inherent head and moisture. Upon the reduction of temperature in the closed cars, the moisture which contains the germs of fermentation become congealed and are deposited upon the surfaces of the food products, to be revived into activity when they are again exposed to the external atmosphere. Under the preparatory or " pre-cooling " method, the germ-laden moisture is expelled from the closed car before its departure, and its contents remain in a dry and sterilized condition until the car is opened at destination. Not only are the perishable products delivered in a more marketable condition but much less ice is required in transit.

I would impress upon the continental managers here present the value of this traffic in perishable products to the railways of the United States; a value so great that lines have been constructed especially to provide facilities for its development in regions well situated as to soil and climate for such industries. The perishable products of the State of California are shipped in train-loads across the continent to the North Atlantic coast. Along the east coast of the peninsula of Florida there is a strip of land lying between extensive swamps and the sea, nowhere more than ten miles in breadth, which was but thirty years ago almost uninhabited. Now it is traversed for over four hundred miles by a railway line, whose principal traffic is in perishable products. From eighty miles of this line, in 1909, there were shipped about 2,000,000 packages of perishables valued at $2,500,000. I mention this particular instance for the reason that it may be compared in some respects with a like distance along the French and Italian Riviera. If similar results could be obtained in that region, profitable occupation could be offered to an industrious agricultural population, who are now expatriating themselves to seek subsistance elsewhere.

The success that has followed upon the introduction of improved methods for protecting perishable products from decay in transit, has cheapened the cost of such commodities in the northern cities of the United States to such an extent that they are now brought within prices which invite their consumption by the masses, with a corresponding extension of their profitable production. In this respect, we may also compare a similar traffic from the Riviera to Central and Northern Europe; a traffic which is specially favoured by the considerable reduction in the average winter temperature that accompanies the transit to these regions beyond the Alps.

I will conclude my remarks by expressing the hope that the railway administrations of Continental Europe will further the amelioration of the agricultural population along the Riviera by such co-operation with the producers of perishable products in that region as will develop this traffic to the extent which has resulted in the United States from similar co-operation. I take this opportunity also to express the interest which I feel in any measures that may serve to increase the prosperity of the European railways. (*Applause.*)

The President. (In French.) — As our German colleagues have finished their meeting, we will resume the discussion of the conclusions.

According to what Mr. Bloch has just said, our German colleagues agree to accept the proposed conclusions he has read out, subject to some modifications.

Mr. Bloch, *reporter.* (In French.) — I will give you in succession the different modifications which our colleagues propose to make in the conclusions which have been brought before you.

As regards conclusion 1, instead of saying :

" The railways could eventually give guarantees concerning this care under strictly-defined conditions and within strictly-defined limits"

we are going to say :

" It may be advisable from this latter point of view, that railways should give guarantees under strictly-defined conditions and within strictly-defined limits."

— The conclusion as amended is adopted.

Mr. Bloch. (In French.) — There is no amendment to conclusion 2.

The President. (In French.) — I accordingly declare it adopted.

Mr. Bloch. (In French.) — In conclusion 3, our German colleagues wish to strike out the words " than by the shorter routes ".

It seems to me that we can give them this satisfaction. (*Approval.*)

— The conclusion as amended is adopted.

Mr. Bloch. (In French.) — Conclusion 4 should be divided into two parts. This is how we propose to word conclusion 4-*a* :

" Although transport with refrigeration, or with special ventilation, or with heating, can be undertaken successfully by railway administrations in very large countries, such as the United States of America or Russia (including Siberia), yet conditions are far from being the same in most of the smaller countries, such as those in Europe.

" In the case of transport in the interior of these countries, on account of the short distance and the quickness of transit, the use of these improved methods, even though it can always be recommended, has not, to anything like the same extent, the same character of necessity. "

Littera *b* comes next, and runs as follows :

" In the case of international transport, it is desirable that the administrations of the European railways should agree to common regulations in order to give such shipments in refrigerator cars all the faci-

lities compatible with the requirements of their services.

" Moreover, owing to the very variable and special attention these shipments require during their whole transit, and owing to the participation of a number of administrations, it appears probable, at least in international traffic, that the operation of refrigerator vans would be managed under better conditions by private undertakings, working for this purpose by agreement with the various administrations concerned."

— Conclusion 4 as amended is adopted.

Mr. Bloch. (In French.) — No amendment to conclusion 5 is proposed by our German colleagues.

The President. (In French.) — I accordingly declare it adopted.

Mr. Bloch. (In French.) — Finally, we have agreed to draw up conclusion 6 in the following terms :

" In order to prevent or diminish difficulties with consignees, resulting from waste ascertained on delivery, in the case of goods specially liable to such waste, it is desirable to supplement, as regards the proportion of waste allowable, the rules in the international agreements. "

— Adopted.

The President. (In French.) — We have thus successively adopted the different conclusions concerning question XVI.

These conclusions will be submitted to the general meeting.

Gentlemen, we have completed our labours. Before closing the meeting, I wish to thank you for your attention and for the information you have given during the discussions. I also wish to thank the secretary-reporters and especially Mr. Etienne who is not only member of the organizing committee but spontaneously offered to join the bureau of the 4th section in order to perform the ungrateful task of acting as translator. (*Applause.*)

Mr. Timonoff. (In French.) — Gentlemen, it was been our good fortune to have as our president an eminent man who was able to fulfil his task with remarkable tact and courtesy, and I accordingly propose that the section should express to him our warmest thanks.

— This proposition was adopted with applause.

DISCUSSION AT THE GENERAL MEETING

Meeting held on 16 July 1910 (morning).

MR. P. WEISSENBACH, PRESIDENT, IN THE CHAIR.

GENERAL SECRETARY : MR. L. WEISSENBRUCH.

FIRST ASSISTANT GENERAL SECRETARY : MR. MÜRSET.

SECOND ASSISTANT GENERAL SECRETARY : DR. A. BONZON.

Mr. Bloch, *principal secretary of the 4th section*, read the

Report of the 4th section.

(See *Journal quotidien de la session*, No. 11, p. 10.)

" Mr. CULP described the main features of his report; he showed that the railways in the United States, which had to convey perishables over very great distances, up to 5,150 kilometres (3,200 miles), were compelled by the American laws to apply the most improved methods for bringing such produce to the points of destination in as nearly perfect condition as possible.

" The different countries to which he had sent his list of questions had to meet very different requirements, and consequently, needed such improved methods to very varying degrees.

" In the United States, there was at the time being a tendency to eliminate or at least reduce the refrigeration service on the road, by applying more and more improved methods, either by precooling the loaded cars, or by simple cooling, either by the vacuum process and by drawing in cold air, or by driving out the warm air by a reverse process.

" The reporter then read out his conclusions.

" Mr. BLOCH then gave a summary of his report. After a short description of the situation and the tendencies of the European market, he considered in succession the tariffs applied in the different countries and the conditions of liability which many of these tariffs involved. He then described the organization and the speed of these transports in different countries, and entered upon the difficult question of the rolling stock, particularly of the refrigeration stock, which was still in a very elementary state in the European countries. He noted the varying tendencies of the different laws and customs in connection

with the settlement of claims and the questions of packing; he then mentioned the propaganda of some of the railway administrations for the development of production, and finally submitted his conclusions in which those of Mr. Culp had been taken into consideration.

" During the discussion, Mr. WIEDEMANN (*secretary-reporter*) in the first place disputed that in countries where there were both State railways and privately-owned railways, there was any difference between the rules applied in the one case and in the other. He noted that in Switzerland the law had not been modified since the State purchase. Dr. ELSNER (*German government*) remarked that the home railway regulations in Germany were not more restrictive than those of the Berne International Convention. Mr. LÜTTKE (*Prussian State Railway*) added that the reductions of the tariffs could have a useful influence on the traffic of cheaper perishable goods chiefly intended for the poorer classes.

" Mr. PICHLER VON DEEBEN (*Austrian State Railway*) confirmed the statements made by the representatives of the German railways, as the conditions of the traffic and the regulations were approximately the same in Austria.

" Mr. SILVA-FREIRE (*Brazilian government*) drew attention to the traffic in tropical fruit, especially bananas.

" Mr. TIMONOFF (*Russian government*) drew attention to the development of the fruit and vegetable traffic in Russia, due to improvements in the tariffs and in the regulations of railways.

" The discussion was closed by the reporter's reply; among other things he stated that he had never expressed the opinion that different rules were applied in any country to State railways and to privately-owned railways, and that the advantage of reductions in the tariffs for cheaper produce also seemed apparent to him.

" Finally, the 4th section unanimously adopted the reporter's conclusions, amended in accordance with the import of the remarks made during the discussion, the following being the text proposed."

The President. — The following are the

CONCLUSIONS.

" The Congress records the great and
" general increase in the perishable-goods
" traffic, which is largely due to the special
" care which all railways devote to these
" very delicate goods.

" The discussion on this question led to
" the following conclusions :

" 1° Although carriage rates can even-
" tually appreciably influence the traffic
" in cheaper perishable goods chiefly
" intended for popular consumption, yet
" as regards the more expensive classes,
" and particularly those of international
" commerce, the development of the traf-
" fic depends chiefly on the care taken to
" ensure that such goods arrive at their
" destination in the best possible condi-
" tion. It may be advisable from this
" latter point of view, that railways should
" give guarantees under strictly-defined
" conditions and within strictly-defined
" limits.

" 2° A very important part of this care
" is however a matter for the producers,

" who should deliver their produce to the " railways in the best possible condition " as regards selection, preparation, con- " dition, etc.; in this connection it may " be useful for railway administrations to " disseminate among producers informa- " tion regarding the kinds of fruit in " demand at the different markets, the best " methods of preparation, packing, etc.

" 3° As regards the acceleration of con- " signments, it is desirable that appro- " priate rates or special rules should be " inserted in the regulations of interna- " tional conventions, so as to give con- " signors the option of choosing the " routes giving them the quickest transit, " the consignments being charged at the " rates fixed for the routes asked for.

" 4° *a*) Although transport with refri- " geration or with special ventilation or " with heating can be undertaken suc- " cessfully by railway administrations in " very large countries, such as the United " States of America or Russia (including " Siberia), yet conditions are far from " being the same in most of the smaller " countries, such as those in Europe.

" In the case of transport in the interior " of these countries, on account of the " short distance and the quickness of " transit, the use of these improved me- " thods, even though it can always be " recommended, has not, to anything " like the same extent, the same character " of necessity.

" *b*) In the case of international trans- " port, it is desirable that the administra- " tions of the European railways should " agree to common regulations in order " to give such shipments in refrigerator " cars all the facilities compatible with " the requirements of their services.

" Moreover, owing to the very variable " and special attention these shipments " require during their whole transit, and " owing to the participation of a number " of administrations, it appears probable, " at least in international traffic, that the " operation of refrigerator vans would be " managed under better conditions by " private undertakings, working for this " purpose by agreement with the various " administrations concerned.

" 5° On account of the difficulties caused " by the return of empties, it would be " of interest, both to the railways and to " the future of the traffic, to promote the " development of the custom of using " packages which are not returned, known " as " *non-returnable emptics.*"

" On the other hand, it seems advisable " to specify in the tariffs the conditions " which packages in general must satisfy, " so as to protect the goods as far as pos- " sible against thefts and the normal risks " of carriage.

" 6° In order to prevent or diminish diffi- " culties with consignees, resulting from " waste ascertained on delivery, in the case " of goods specially liable to such waste, " it is desirable to supplement, as regards " the proportion of waste allowable, the " rules in the international agreements."

— These conclusions were confirmed by the general meeting.

APPENDIX

[625 .244 & 656 .235.7]

ADDENDA TO REPORT N° 1

(Countries using the English language)

By J. M. CULP,
VICE-PRESIDENT, SOUTHERN RAILWAY.

CHAPTER I.

Additional matter regarding Kosher meat : Vegetables requiring refrigeration; Description of ice tanks in beef car; Results from pre-cooling furnished by Roy.

Fresh meats, products of abattoir, etc.

A fact interesting to Jewish patrons is the careful attention paid, not only by Packers but by Transportation Lines, to the preparation and shipment of meat bearing the approval of the duly constituted authorities of the Jewish Religion. After this meat receives the stamp of the Rabbi, it is not differently handled in any material sense from other classes of fresh meat, but to comply with requirements, the meat must be delivered to consumer within seventy-two hours of its slaughtering. This means it cannot be retained in the coolers at Packing Houses for the full time required for complete chilling, dependent always, of course, upon the estimated schedule to the consuming market.

The chilling of the meat is therefore continued during transit and necessitates closer attention to icing of cars, both at packing houses and in transit, than is the case where meat is loaded in a perfectly chilled condition.

While meat for ordinary American trade, which has been chilled by ordinary

processes, moves into market within sixty days of its slaughtering, it sometimes happens that the meat is held as long as ninety days and still delivered in edible condition.

—

Consideration should be given to the efficiency in the preparation and transportation of fresh meat of pre-cooling systems now being employed by carriers in handling of fruits and vegetables. It is claimed for one of these systems, namely, the *Intermittent Vacuum or Sprague System* (Southern Pacific), that meat may be cooled down to the required temperature of 30 to 34° in two hours, as against estimated requirement of forty-eight hours under the present plans. Our investigations do not develop that this experiment has actually been made.

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Descriptions furnished of cars for handling fresh beef and other meats under ice, allude to a system of ice tanks over a drip pan connected by a pipe and trap with the outside, permitting the outflow of the drippings. This description may be amplified by stating that the drippings which flow into the pan under the ice tanks come from moisture precipitated upon the side of the tanks, usually in the shape of frost. The overflow of the contents of the tanks takes place through a tube arranged inside of one of the four tanks situated in the ends of the beef car. These four tanks are connected by a small pipe, and as the liquid brine is formed in each tank by the melting of ice, it rises to the same level in each of the four tanks. The overflow of this brine escapes through the tube just alluded to, which discharges through the same outlet in the floor of the car as provided for the escape of the drippings from the outside of the tanks. A valve is provided at the bottom of the tank containing the overflow tubes to permit the complete emptying of all the tanks.

Fruits and vegetables.

Cantaloupes are usually shipped under ordinary icing, the same as provided for other highly perishable fruits and vegetables at a temperature of about 45 to 50°.

We find, on investigation, that there is no vegetable in America which is invariably shipped under refrigeration, but those most commonly requiring refrigeration are : lettuce, celery, spinach, asparagus and radishes. All vegetables except ordinary perishables, are shipped under refrigeration at times. The practice of one of the largest carriers of vegetables indicates that about 60 per cent of the vegetables move under ventilation at all times; about 40 per cent will require more or less ventilation.

The Bohn Collapsible Ice Tank applied to Refrigerator Cars.

A very interesting improvement in transportation appliances which has come to our attention, is the Bohn Refrigerator Car, equipped with collapsible ice tanks, the essential feature of which is the movable partition, or wall of the ice tank inside the car. When this wall is in position (fig. 1) to receive ice in the bunkers, it affords a receptacle for the ice, not essentially different from the stationary ice

tanks in the ordinary refrigerator car for fruit and vegetable movement, and that is a zinc lined compartment (expanded metal) with grates at the bottom, underlaid by a drip pan with the usual discharge pipe for the overflow. The movable partition or wall described above, can be lifted up (fig. 2) and fastened to the top of the car (fig. 3); and the grates are also folded up, and there is added to the cubic contents of the car for the loading of ordinary fruit not less than 11 to 12 per cent. This device has already been adopted by the Union Pacific & Southern Pacific Lines in the construction of about twelve hundred Pacific Fruit Express refrigerator cars. Chief Freight Traffic Officials of those lines are enthusiastic over the results. The addition to the initial cost of the equipment is about 10 per cent. The increase in the dead weight is 1,000 lb. but the increased loading capacity for the character of freight transported in refrigerator cars, completely offsets the additional cost and the increased dead weight. Furthermore, there is an advantage from readiness of cleaning, the car with the ordinary ice bunker requiring considerable effort and time to effect thorough cleansing, whereas with the collapsible tank, permitting access to the remotest corner or crevice of the car, a thorough cleansing is possible.

Pre-cooling.

Our attention was drawn to results of experiments on pre-cooling as now conducted by Pacific Fruit Express Management in California.

In the case of vegetables, experience has proved that the pre-cooling of celery added to its value in Eastern markets about 50 dollars per car, as against ordinary icing; pre-cooling of cauliflower added 300 dollars per car.

Shipments of strawberries precooled and shipped under initial icing only, were transported 1,000 miles to Salt Lake City and kept in good condition five days after arrival exposed to the air.

A comparison of shipments of celery, one pre-cooled under initial icing, the other under standard icing presented the following results :

At the end of the second week celery shipped under standard icing showed some signs of deterioration, at the end of the third week the shipment had to be sold immediately to prevent entire loss; on the other hand, at the same time, the contents of the pre-cooled car showed absolutely perfect condition and sold for 1 dollar per crate more than the shipment under standard icing.

The Intermittent Vacuum principle serves to withdraw impurities, including the inherent germs of decay, while it supplies the chilling effect. The elimination of impurities is shown by the intensely foul air observable at the discharge pipes during the operation of the suction or vacuum process.

The Intermittent Vacuum principle contemplates the application of a blast of cold air for a period of five minutes followed by the suction or withdrawal of air from the contents of the car for a period of three seconds. It is during this period of suction that the bad odors are observable. No deterioration in texture or taste has been observable as the result of the expulsion of the impurities by the suction process. On the contrary, fruit can be allowed to remain on trees to point of

full maturity before gathering. This possible benefit has already been alluded to in the report.

Experience shows no loss in weight from the application of pre-cooling.

In the case of cabbage shipped under ordinary icing reaching destination in four or five days, the hatches were hard to hold down because of gases from deterioration and decay. A pre-cooled car for the same distance showed no impurities or gases.

A shipment of cantaloupes from an outlying district of Los Angeles was pre-cooled before shipment to 38°. It was handled into Los Angeles, held there a period of three days, at the end of which time fifty boxes of oranges were inserted in the car; the car closed up and held one day. When the car was opened at the end of the fourth day the oranges were found to be cool. The major part of the load of cantaloupes was taken out and shipped to Goldfield, Nevada, a distance of 531 miles, and exposed on the stands of fruit sellers for seven days, when they were found to be perfectly sound and in cool condition.

The appliances lowering the temperature of pre-cooled cars are regulated by a thermostat insuring the production of the temperature desired.

Advocates of pre-cooling claim no initial icing will be required for distances calling for three and a half or four days' movement. They further claim that intermediate icing may be entirely done away with. This latter statement is borne out in a case of shipment of oranges from Los Angeles to New York, which moved under initial icing only, and it was found that the temperature at destination had risen only 2°.

Extracts from annual reports of chief of Bureau of Plant Industry, 1901-1908, United States Department of Agriculture.

During the year 1904, an investigation of the causes of the decay and softening of perishable fruits, like the peach, during transportation to market was begun. It has been discovered that a large part of the difficulty is due to bad handling or improper condition of the fruit before it is placed in the refrigerator car. Through the co-operation of the Hale Georgia Orchard Company at Fort Valley, Ga., a number of carloads of peaches were forwarded to northern markets and an accurate record of the condition of the fruit in different parts of the cars was made. The fruit was packed in the six-basket carriers commonly used for peaches in that State, the carriers being loaded five tiers high in the refrigerator cars in the usual way. It was found that under the conditions experienced at Fort Valley, the fruit often has a temperature of 90 to 95° Fahr. when loaded. Under present practice, the ice in the refrigator car is expected to do the initial cooling as well as to maintain the desired low temperature afterwards. Early, tender-fleshed varieties, like Carman and Waddell, and firmer kinds, like Belle, Thurber, and Elberta, were included in these tests. The early, tender-fleshed varieties often showed from 5 to 20 per cent of soft and decayed fruit in the two upper tiers in the car, while the three bottom tiers arrived in the northern markets in sound condition. This unequal condition on arrival is unquestionably due to the more rapid cooling of the fruit in the bottom of the car, and emphasizes the conclusion previously reached in these investigations, that quick cooling after picking is a fundamental requirment in successful cold-storage operations. To test the accuracy of this point,

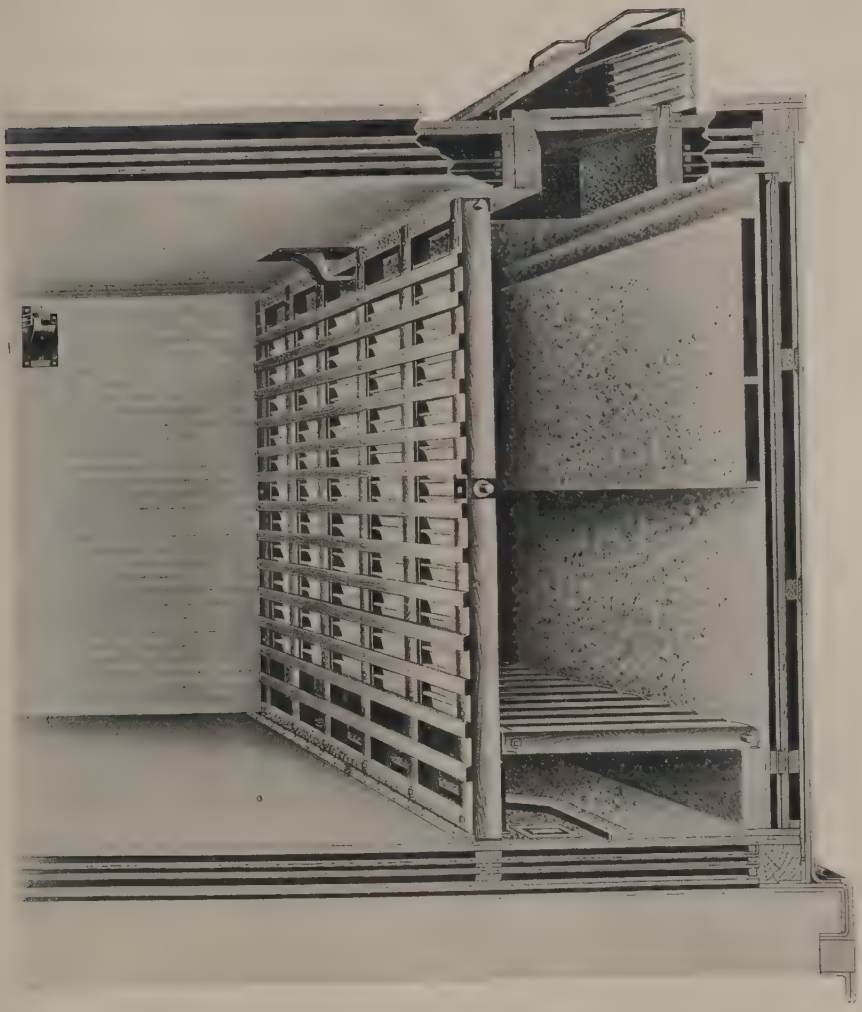

Fig. 1. — Bohn collapsible tank. — Bulkhead and ice grate in position for icing.

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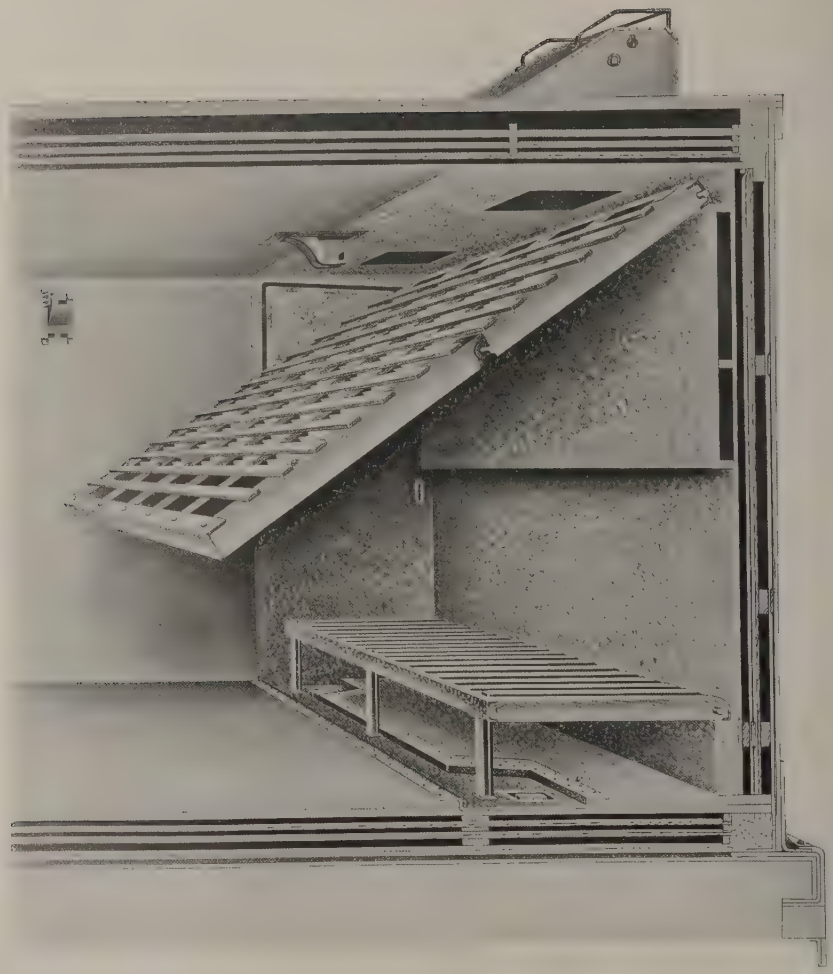

Fig. 2. — Bohn collapsible tank. — Bulkhead partly raised.

Fig. 3. — Bohn collapsible tank. — Bulkhead raised in under roof.

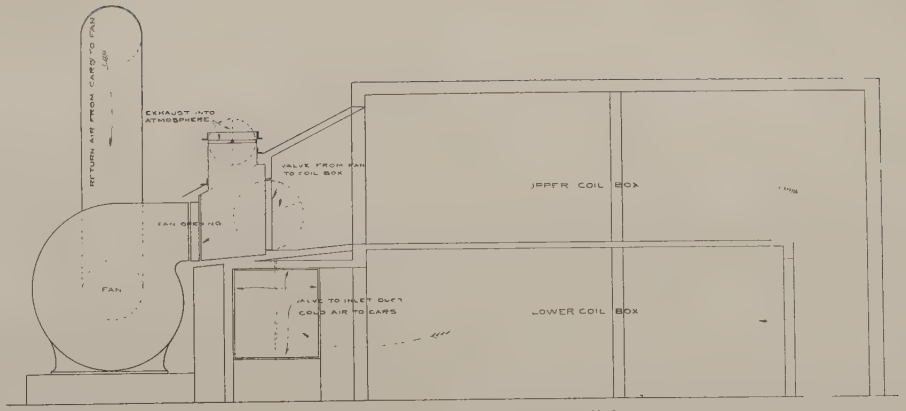
RETURN AIR FROM CARS TO FAN
EXHAUST INTO ATMOSPHERE
VALVE FROM FAN TO COIL BOX
FAN CASING
FAN
VALVE TO INLET DUCT COLD AIR TO CARS
UPPER COIL BOX
LOWER COIL BOX

Fig. 4. — Section through coil box.

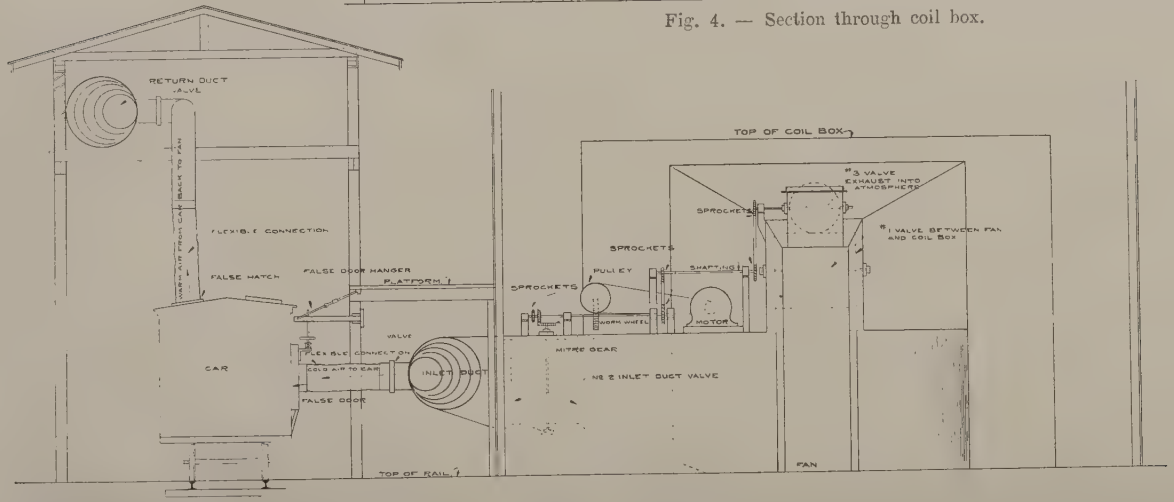

Fig. 5. — Elevation.

Figs. 4 and 5. — General arrangement of ducts and car connections for precooling.
Intermittent Vacuum Faget Precooling System Co.

a temporary cooling plant, consisting of two refrigerator cars, was devised in an ordhard of the Hale Company. In each of these, half a carload of fruit was placed for cooling prior to loading in cars for shipment. These coolers were refrigerated by using ice and salt in their ice bunkers, the temperature of the fruit being in this way reduced to about 40° Fahr. in about twenty four hours. Fruit loaded at at the same time into refrigerator cars with ordinary icing did not reach a temperature of 40 to 50° Fahr. within three to five days. After the fruit in the coolers had reached a temperature of about 40° Fahr., it was transferred to a refrigerator car and sent North under regular icing. *Nine* carloads of *peaches*, or about 6,000 packages, were forwarded under these conditions, with the result that practically all of the fruit arrived in New York and other northern markets in sound condition, with no loss even in the upper tiers of carriers. Recording thermometers showed that under these conditions the ordinary icing of the car maintened in transit the low initial temperature of the fruit. Peaches handled in this way can be left on the trees until much riper, and therefore until they possess finer flavor and higher color than is possible with ordinary shipments, and still will arrive at destination in perfectly sound condition. After removal from the car, such fruit remains sound longer than the prematurely picked fruit shipped under ordinary icing.

Milk shipments.

We find that small shipments of milk are being made from time to time from Chicago to New Orleans, a distance of 921 miles, the movement taking place under ordinary refrigeration.

CHAPTER II.

Pre-cooling, as developed and practiced by the Southern Pacific Company, in California.

This company uses what is known as the " Intermittent ", or Sprague-Edson system, and has spent considerable time and money in developing this. In general, the process of pre-cooling, is to rapidly refrigerate fruit, vegetables, melons and other perishable goods, at the point of shipment, in the cars in which they are to be transported. There are several advantages in this process, of which the most important is that the fruit, etc., so pre-cooled may be allowed to become thoroughly ripe before shipment; and the transportation of any fruit or vegetable, however delicate it may be, for long distances, becomes feasible and practicable, so that at the point to which it is consigned it will be received in practically the same condition as that in which it was shipped. The well-known method of shipping fruit in ice-cooled cars is, of course, a vast improvement on no refrigeration at all, but it is open to the very great objection that the temperature of the

car is so gradually reduced by icing that it takes two or three days before the entire contents of the car are cooled down to a point at which decay is arrested, for which reason it is necessary to ship perishable goods in a more or less unripe condition to allow for further ripening in transit. It is evident, therefore, that any process, which can greatly expedite the initial refrigeration of a car will permit of the shipment of fruits, melons, etc., in just so much more perfect condition as regards ripeness. This is precisely what pre-cooling does; that is to say, that by the use of this method, a carload of fruit may be so quickly brought below the point at which decay is arrested, that the contents may be absolutely ripe when shipped, and may be delivered to the consignee in practically the condition in which they were picked.

Besides the element of temperature, the emanations from the fruit itself are aids to decay and it has been found to be of great advantage to be able, not only to lower the temperature of the contents of the car, but to withdraw therefrom the heated air given off by the contents, and supercharged with foul gases and emanations; so that the " Intermittent " system in use by the Southern Pacific Company is devised to accomplish both these results; namely, refrigeration and purification. The apparatus for this purpose consists in forcing air through a false door, or other aperture, at, or near the middle of a car, and distributing this air through the boxes of fruit packed in the car, by means of suitable deflectors and baffles. The cool air passes into the car in a continuous stream, and is withdrawn from the end hatches by means of temporary connections. At suitable intervals the inlet is closed for a brief time and an exhaust maintained in the outlet pipes, so that a partial vacuum occurs in the car. During this part of the process, the exhaust air is discharged into the open air, or vasted. The inlet is then opened and the exhaust into the outer air closed, so that a circulation of cold air through the car is resumed. The cold air after circulating through the car, is passed by suitable fans over and through a coil of cooling pipes so as to condense moisture or essential oils emanating from the fruit, or rather, that small portion of these which is left in the air after the vacuum process. The amount of vacuum, the frequency of its application, and the length of time during which it is maintained, should vary with the kind and condition of fruit, vegetable, etc.

To sum up, by this process not only are the contents of the car refrigerated, but they are also surrounded by sweet, clean air, sterilized by refrigeration. After pre-cooling, the cars are fully iced as usual, so as to maintain a low average temperature during shipment. This preserves the delicate flavor of fruits, berries, and vegetables shipped for long distances, and they arrive in a condition not heretofore possible under ordinary refrigerating methods; and there is evidence to show that the contents keep better when exposed for sale than fruit which has been shipped in the ordinary way.

In reference to description of Plant at Colton, would say that the Plant was originally installed for a 200 ton ice making Plant. However, with recent improvements we have been able to bring

this up to approximately 300 ton per day of twenty-four hours; this while not precooling, as the precooling itself takes quite some little power and of course, reduces the ice making capacity in proportion.

The Boiler Plant is of 1,000 horsepower capacity, divided into three units, two of which are in constant use and one in reserve.

The precooling portion of the Plant consists of two precooling sheds, each being of sufficient dimensions to permit of the precooling of twenty cars at a time, or a total of forty cars.

The double shed being for the purpose of facilitating the handling of the connections to cars, as immediately after one set has been precooled, the other having been attached no delay occurs, or in other words, the precooling could be continuous, and would therefore permit, with the present size of Plant, of precooling between one hundred and sixty and one hundred and eighty cars per day of oranges and of approximately four hundred cars of vegetables, this reducing the temperature from 80 to 40° Fahr., with an actual running time on each set of (20) cars of about two hours and one-half to three hours. The total amount of air circulated per minute when handling (20) cars is approximately 200,000 cubic feet, this is a velocity varying from 6,000 to 8,000 feet per minute.

The inlet and outlet connections to cars being so proportioned that immediately upon entrance of air into body the pressure drops. In other words, we retain the quantity of air and the velocity and reduce the pressure in the car to that practically of the atmosphere. This so as to prevent either the ingress of hot air and the egress of cold air, this to minimize the refrigeration losses as much as possible.

To further carry out this idea each precooling station is divided into two units, each unit in itself being divided into two parts, thereby enabling us to handle any number of cars from one up to the maximum capacity of the plant with practically the same efficiency.

The intermittent Vacuum System has now been arranged so as to operate entirely automatically. During the first hour, the valves being opened every five minutes and remaining open for a very short period, this sufficiently long to discharge the fruit emanations and to replace it with fresh cold air; during the second hour this operation taking place every ten minutes, and so on throughout the entire precooling period according to conditions.

The figure 4 shows the delivery and exhaust system, direction arrows showing movement of air currents.

For cars with different sizes of openings, there has been designed an independent plug into which a regular plug attached to flexible connection is inserted, which permits the meeting of almost all conditions. The joint in the plugs on the outlet as well as the false door in the inlet side being arranged with inflated tubes and canvas so as to make a practically tight joint with car body. The connections themselves are made up of several layers of rubber and canvas in " accordion " fashion, with an annular air space and which, while being very flexible and taking care of almost every possible condition, also prevents refrigerating losses; in fact, it has been worked very successfully. Each inlet and each outlet are also constructed with

a specially designed valve so that any car can be cut out (without interference to the others) and which is done when three or four cars are precooled.

As to any dead portions of car, it is stated that the quantity of air and the velocity which we use, and which is the only method by which we could use such low temperatures and precool in a length of time satisfactory to the Transportation Department, entirely prevents any possibility of their being a portion of car body in which there is not a rapid circulation.

There are two sections of the Coil Box where the air is cooled, both containing Ammonia Coils through which the air from the Fans is blown, the air first going into the upper section from the Fan, thence down into the lower section and through the series of Valves and Connections into the Inlet Duct marked « *Cold Air to Cars* », thence through the Flexible Connections and False Doors into the car body and out from both ends at the top through the Flexible Connections into the Return Air Duct which is shown on one side (fig. 4) to better illustrate and from the Duct back into Fan again and so on, thereby forming a continuous circulation of cold air.

The arrangement of the Valves for operating Intermittent is shown on figure 5. The idea being that the apparatus being all worked through gearing and shafting operates simultaneously. That is, the Valve on Inlet Air Duct marked No. 2 and the Valve marked No. 1 would simultaneously close with the opening of Valve No. 3. The closing of Valve No. 2 prevents any cold air passing from Coil Box into the Cars and the Closing of Valve No. 1 prevents any air from the Fan being discharged into the Coil Box so that the Fan is simply drawing the air from the cars and discharging it through Valve No. 3 into the atmosphere, thereby producing a partial vacuum in the car bodies, as Valve No. 2, being closed tight, will not permit any air to enter through the Inlet Duct. In other words, the whole and entire apparatus is made so that when Valves No. 1 and No. 2 close, No. 3 opens, thereby stopping the current of cold air from entering the cars, the Fan then drawing the foul gases from the cars and blowing it into the atmosphere.

The method of operation being to make all the connections to the cars and then exhaust the air from the cars for the first few minutes, discharging this through Valve No. 3 into the atmosphere. The opening of Valves No. 1 and No. 2 and the closing of Valve No. 3, thereby blowing the air from the Fan through the coil-box in through the cars drawing this air into the Fan again and through the Coil Box and so on indefinitely. The automatic operation of the Valves takes place every five, ten or fifteen minutes according to the condition of fruit whereby the flow of air into cars is cut off and this vacuum process gone through and so continuously throughout the entire precooling period. These Valves automatically open and close thereby discharging a certain quantity of air into the atmosphere and replacing it with cold fresh air. In other words, the Intermittent Process is worked at the time given and this according to the condition of the fruit itself. The flexible connections

shown are worked on Swing Joints on the Outlet from cars so that they can be swung out of the way the moment car has been precooled and is ready for icing. The same thing being done with the False Door, where the cold air enters. The idea being to handle the cars as quickly and with as little labor as possible.

CHAPTER III.

Precooling as developed and practiced by the Atchison, Topeka & Santa Fe Railway, in California.

In addition to the Sprague or Intermittent Vacuum System of precooling, there has been developed since the preparation of the original report a system which may be called the Gay, invented by Mr. C. M. Gay, and described briefly as follows :

A fundamental feature of the Gay system of precooling is a rapidly driven current, or blast, of cold air, in the application of which to the space enclosed by the walls of the car the excess over normal atmospheric pressure in the delivery or blast duct is equalized by a corresponding deficit below normal atmospheric pressure in the exhaust or return duct. The balance thus effected occurs exactly at the center of the car, and, it is claimed, the penetrative efficiency of the blast is fully maintained, with minimum loss of refrigerating energy due to unavoidable leaks in the car.

This balance of pressure is preserved by a valve located in the partition between the blast duct and the exhaust duct at their common extremities, and operates automatically.

The blast and exhaust currents are created by fans; one situated at the entrance to the blast duct and delivering thereto cold air from the cooling room; the other situated at the end of the exhaust duct, drawing the air therefrom after it has performed its cooling function, and returning it to the cooler room to be re-cooled and again started on its circuit.

Another primary feature of this system is the large intake valve to permit replenishment of atmospheric contents of the system. This valve is situated in the outside wall at the extreme end of the exhaust duct and so adjusted by tension spring to automatically admit air from the outside, when the inside atmospheric pressure goes below that determined by the differentiating valve described in the foregoing paragraph.

This system has been adopted by the Atchison, Topeka & Santa Fe Railway in connection with an ice-making and precooling plant at San Bernardino, California, which was in course of construction when inspected by us. No photographs were available, but blue prints showing essential features are submitted (figs. 6 to 8).

The combined ice making and precooling plant of the Santa Fe Railroad at San Bernardino, California, is a reinforced concrete structure with a total length of

1,360 feet, or something over a quarter of a mile. The ice making capacity of the plant is 250 tons per day of can ice with a day and winter storage whose combined capacity is 30,000 tons. The power plant is equipped with three 350 horse-power Stirling boilers and two cross compound, duplex, Vilter, refrigerating machines each of 300 tons capacity. The ammonia condensing system is of double pipe type placed over a concrete reservoir 80 feet square and 10 feet deep. A water supply of about 500 gallons per minute is furnished from an artesian well whose flow is accelerated by air lift to the required amount. A large day storage, 120×142 feet, gives a capacity of 900 tons of ice when covered by one tier of 300 lb. blocks on end. The winter ice storage is divided into four rooms of something over 7,000 tons storage capacity for each room.

The precooler equipment (figs. 7 and 8) extends from the end of the winter storage and is equipped for handling thirty-two refrigerator cars at a setting. The main air ducts of the precooler are of concrete and form the support of the car icing platform. The precooling system has been installed by Mr Gay under his designs and patents.

The air is cooled by galvanized brine pipes located in coil chamber at the end of the winter storage. The brine used is taken from the ice tanks by electrically driven pumps sent through its refrigerating circuit and returned through a 200 ton double pipe brine cooler which together with the circulating pumps is located beneath the day storage. A double deck tunnel or passage-way of reinforced concrete extends through the winter storage from the precooler to the day storage where the tunnel continues as a single tunnel beneath the day storage to the double pipe cooler rooms.

All of the ice is handled by direct conveyor passing the day storage and through the upper section of the tunnel through the winter storage where it may be diverted to the storage rooms or carried on to the car icing dock as required. The lower compartment of the tunnel is used for the brine mains running to the winter storage and to the pre-cooler coil chambers.

The whole storage house is insulated with " Nonpareil " cork board, the floors being made of concrete covered with cork board and a finishing floor of asphalt. The roof is insulated with " Linofelt " and air spaces. As all the ice is handled through the central tunnel of the day and winter storage room there are no outside openings or exposures whatever.

The air circulation in the main precooler ducts is accomplished by eight No. 11 Sirocco fans with a combined capacity of 300,000 cubic feet of air per minute. The concrete main air ducts are internally insulated throughout with cork board and " Linofelt " and the main air ducts are themselves piped with 50,000 feet of $1\frac{1}{4}$ inches galvanized brine pipe.

Four of the Sirocco fans are used to exhaust from the upper main duct delivering the air to the coil chamber. The other four draw the air from the coil chamber and deliver to the lower or main pressure duct. Extending from these ducts the lateral air pipe connections are fitted with liquid sealed revolving joints in such a manner that connection can be made to a whole train of cars without uncoupling or spotting the cars and whether the cars are of uniform lengths or not.

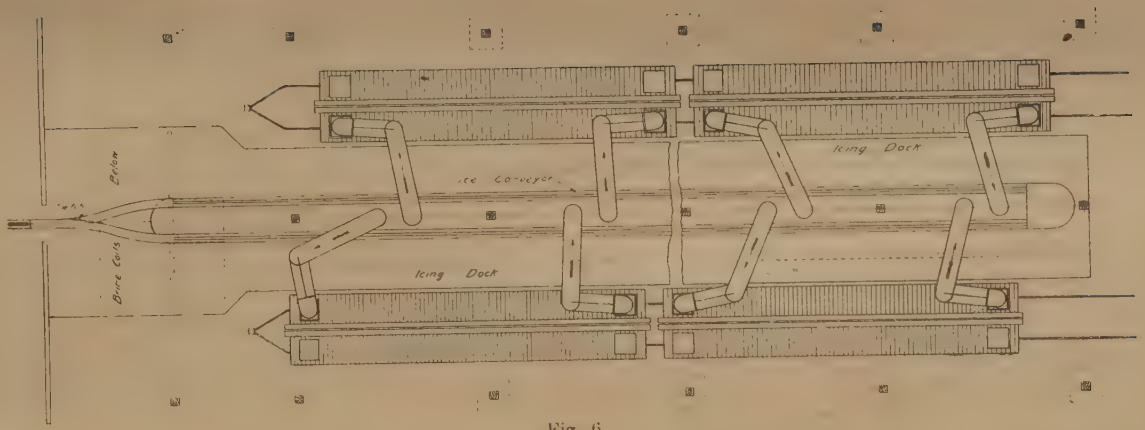

Fig. 6.

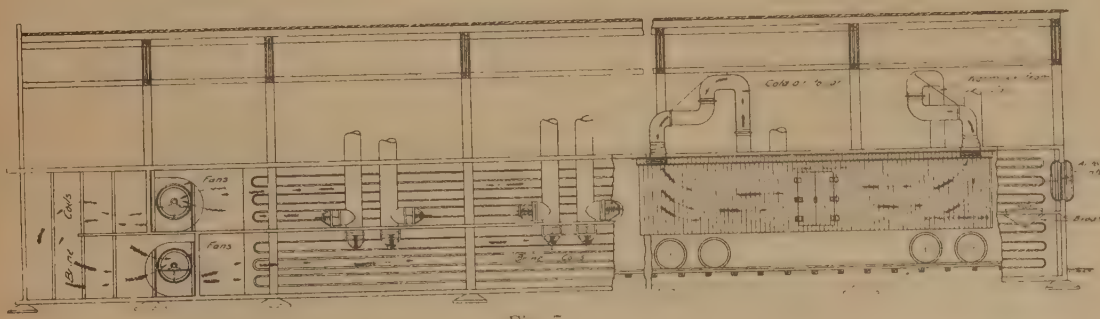

Fig. 7.

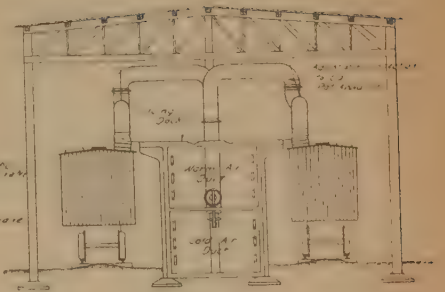

Fig. 8.

Figs. 6 to 8. — Gate City ice and precooling plant, San Bernardino, Cal. — Gay patent precooling system.

At the extremity of the main air ducts furthest from the coil chamber, a large automatic valve connects the pressure and vacuum ducts and by regulation of the tension at which this valve is held closed the pressure at which the air is delivered to the cars and the suction at which it is withdrawn from them is regulated at will.

At the extreme outer end of the main suction duct is also located an automatic intake valve for replacing any air lost from the system by blowing the warm air from the cars. This valve is regulated at a differential pressure as between the external atmosphere and the slight vacuum held in the low pressure duct so that when the total amount of air being circulated is reduced, this valve immediately opens to supply such deficiency at the beginning of the refrigerating circuit. Such air must then pass the full length of the main refrigerating suction duct through the coil chamber and be delivered back to the high pressure duct before it can enter the cars. Each lateral pipe has a valve opening into both the high pressure and low pressure main ducts. These valves in the respective ducts are controlled by the same lever or crank thus securing the effects of cross connection and reversal of air current without cross connecting the laterals. To summarize the novel and striking features of this system as installed at the San Bernardino plant we have :

The combination of main air ducts and car-icing platform and ice-carrying tracks all in one structure.

The refrigeration of the main ducts from the coil chamber to their extremities keeping the circulating air under refrigeration at all times except when passing through the short lateral connections extending to and from the car.

Liquid sealed revolving joints on lateral connections give universal horizontal adjustment in connecting to the cars.

Automatic by-pass valve at extremities of main air ducts capable of being regulated to secure any required differential pressure as between the high and low pressure main ducts.

Automatic intake at beginning of refrigerating circuit to insure the proper cooling of any outside air brought into the system during operation.

The prime object aimed at is to secure the circulation of a very large amount of air through a car without loss by forcing the cold air to the outside or drawing warm air in from the outside through the car itself.

Mr. Gay's experiments proved conclusively that all refrigerator cars are far from being tight. Experiments on a large number of cars showed that with a car closed as tightly as possible, an air pressure equivalent to $^1/_2$ inch of water would result in a loss of air through unseen openings of from 800 to 2,000 cubic feet per minute, and that an equivalent vacuum would produce practically the same result in the amount of air drawn in from the outside. Consequently, in order to perform the function of precooling in an efficient manner and without great loss of refrigerating capacity it was highly necessary that exactly as much air be withdrawn from the car as was being forced to it and that the system must be so balanced that the point of equalization between the pressure coming from the main pressure duct and the suction coming from the main return ducts, should be as nearly as possible in the center of the car.

To accomplish this, the two sets of fans were installed, the function of one being to blow from the cooling chamber directly into the main pressure ducts, and the function of the other being to withdraw the air from the vacuum duct with the same amount of differential below atmospheric pressure that is shown in the pressure duct above atmospheric pressure, thereby insuring the point of equalization as between the high and low pressure sides being maintained at practically the center of the car. So nicely can this be balanced that the side doors of a refrigerator car may be opened during the process of precooling without any blast of air being felt going out or coming into the car although 6,000 to 8,000 cubic feet, of cold air per minute is passing through the car.

It is the practice in refrigeration, to connect the pressure duct to the bunker openings first, opening the valve allowing the air pressure to drive out the warm air in the car, and as soon as the warm air has been expelled, to attach the return or suction connection at the opposite end of car and open the valve communicating with the main suction duct; thus completing the circuit of the air through the car. It is evident that in displacing the warm air in the car before connecting the suction duct, that an equivalent amount of air is withdrawn from the refrigerating system thereby lowering the pressure in both of the main ducts. The automatic intake valve is so regulated as to respond to the lowered pressure admitting an equivalent amount of outside air at the beginning of the refrigerating circuit. Were it not for the location of this valve providing for taking the air in at the beginning of the circuit, it would naturally come in at any place past the centre of the car towards the return side where the pressure would naturally be lowest. Such air coming in at this point in the car itself would naturally have the effect of nullifying the refrigerating effect of the air circulation and lowering the efficiency correspondingly, besides having a tendency to precipitate moisture in the wrong place instead of precipitating moisture on the cooling pipes in the main ducts and cooling chamber. Closing connection between the lateral air pipes and the car bunkers is effected by a bellows joint which preserves the entire area of the pipe under all adjustment.

The lateral pipes have an internal diameter of 22 inches.

The amount of air which can be circulated through each car is about 8,000 cubic feet per minute with thirty-two cars connected at once. The maximum amount allowed for cooling these cars is four hours, which together with the icing which is performed with the cars in the same position gives a total time of less than five hours per setting. This gives the San Bernardino plant a maximum precooling capacity of thirty-two cars every five hours.

In this plant provisions are made for complete metering of all brine used in precooling and for cooling the ice storage rooms, and with thermometers giving the temperature of the metered brine. Main air ducts and laterals are provided with barometric columns showing pressures at which air is circulated and returned and instruments are also provided for measuring the velocity of the air in both feed and return laterals giving opportunity for keeping a complete refrigeration record

on every car that is cooled. In addition to this long test, thermometers will be used extending to the center of boxes in car showing the temperature to which the fruit is cooled during the operation.

This means instruments provided to show : 1° air pressure by barometer; 2° the velocity of blast of air passing through car; 3° the temperature of the fruit in the car.

CHAPTER IV.

Description of Garland improved ventilated refrigerator car.

We have personally inspected improvements which have been made in the Garland Ventilating Device, resulting in a combination of ventilation, refrigeration and steam heating described as below and illustrated in figures 9 and 10.

The Garland refrigerator car. — This car is designed to protect shipments of fruits, vegetables and other perishable freight at all seasons of the year, the arrangement being to furnish ample refrigeration, ventilation, or heating as may be required.

The car is constructed with the usual ice tanks (figs. 9 and 10) at each end of the car with hatch openings, plugs and hatch covers. The drip pans are raised about 15 inches from the floor of the car and the ice grates are about 12 inches above the drip pans. Inside of each ice tank, in the center, and next to the end of the car is an air duct 10 inches square (inside) extending from the top of the pan to the floor of the car, opening at the bottom towards the body of the car.

At the upper end of the duct is a square opening through the end of the car. A padded hinged door is fitted to this opening on the outside of the car and over this door is a galvenized iron duct or air in-take which extends above the roof of the car, and at one side of the running board. On the upper end of this duct is a reversible hood which is ajusted to take in air when the car is running in either direction. This hood is placed in proper position at loading point and is not changed unless the car is turned while en route.

On the roof of the car near the center are placed two exhaust ventilators with square openings down into the car. At the underside of the openings are placed padded plugs which fit into the openings and are opened or closed by means of levers on the roof.

On the floor of the car is placed a slatted flooring which is divided into five sections, two sections at each end and a center section. The end sections are divided at the center and are hinged at each side permiting them to be raised up against the sides of the car. The center section is not hinged, but is held in place by the end sections when down.

There is a space of five inches between the regular floor and the slatted floor. In

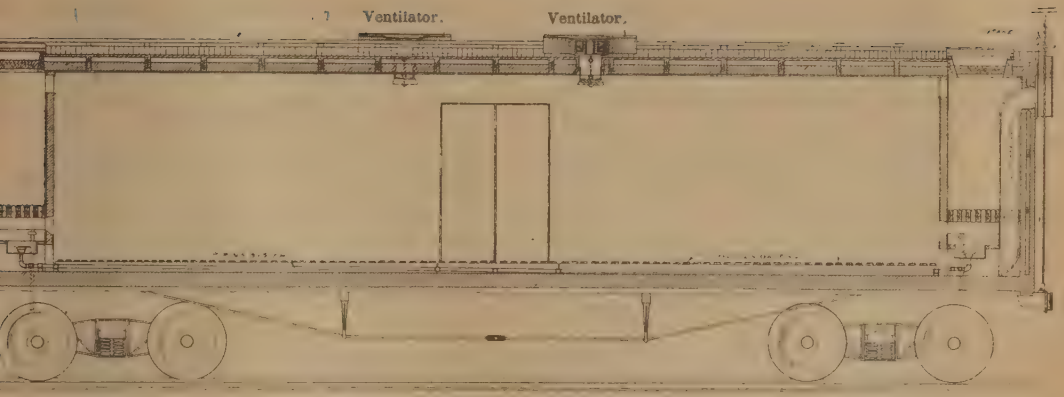

Fig. 9. — Longitudinal section of car.

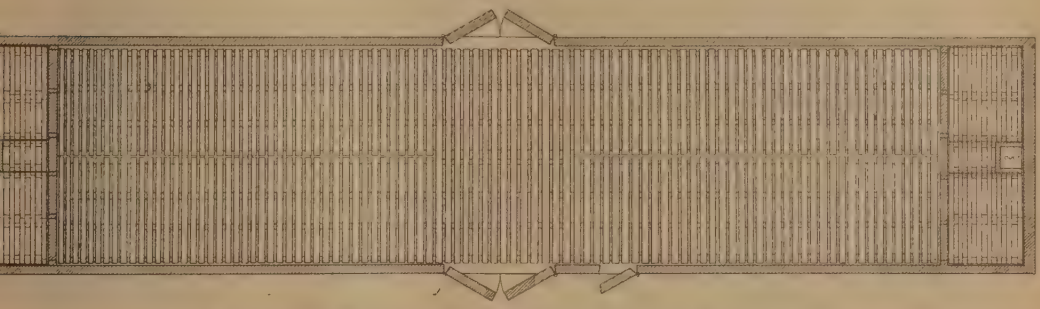

Fig. 10. — Floor plan, showing floor and ice racks in place.

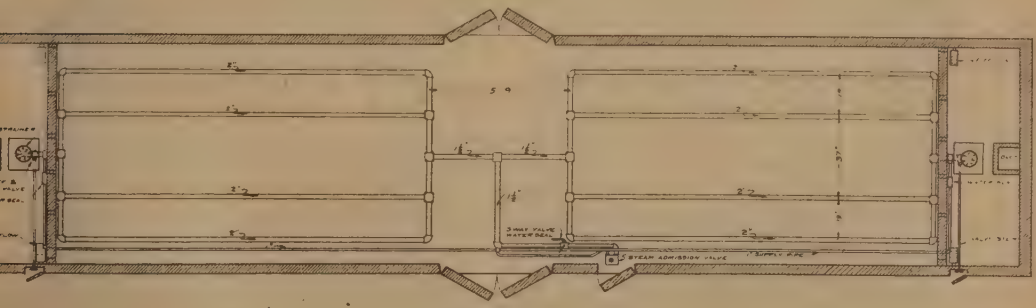

Fig. 11. — Floor plan, racks removed, showing piping system.

Figs. 9 to 11. — Garland system of refrigeration, ventilation and heating of refrigerator cars.

this space is placed iron piping (fig. 11) resting on the lower floor and arranged for heating and cooling. The vapor system of steam heating used on passenger equipment is applied to this car. With this system there is no steam pressure in the pipes inside of the car, the pressure being on the train line only. The controlling valves are located under the slatted floor at one side of the car, being accessible through a small door in the side of the car.

Connected with the pipes at each end of the car is a drain from the drip pan under the ice tank. This drain is arranged to receive the water from the melting ice, when the car is under refrigeration and conveys it to the same pipes used for heating. The cold water flows from each drip pan through the piping and is discharged at the center, and to one side of the car. The water is trapped at the center to keep the pipes full all the time the car is under ice.

At each end of the piping in front of the drip pan and under the slatted floor, are valves attached to the drain pipes from the drip pans. An extention handle is attached to each valve running through the side of the car, so they can be operated from the outside of the car.

At the side, accessible through the small door is a three-way valve to regulate the discharge of ice water, either through the trap under the car or through the goose-neck outlet. To keep the pipes filled with ice, water the handle of three-way valve should be turned crosswise with the car; the water will then discharge through the goose-neck. To drain the pipes of ice water, turn the three-way valve lengthwise with the car; the water will then discharge through the trap under the car.

In the wall of the car on one side, is placed a thermometer, the bulb being located in a pocket exposed to the inside of the car, while the registering plate is located flush with the outside of the car over which is a heavy glass and iron slide. The temperature inside the car may be read from the outside.

Car under refrigeration. — When the car is to move under refrigeration, the ventilators on the roof at the center should be closed and the air intakes at each end should also be closed, except as noted below. The drain valves at each end of the car in front of the drip pans should be opened, and while the car is under ice, the three-way valve should be turned crosswise with the car, so the pipes will remain full of ice water and discharge through the goose-neck outlet. When the car is unloaded or ceases to be kept under ice, the three-way valve should be turned lengthwise with the car, so the water in the pipes will drain off.

When the car leaves shipping point with a load of fruit, berries, etc., it is desirable to have a circulation of air through the car for the first one hundred miles or more, in order to carry off the heat and gases generated by the lading. It is therefore advisable to open the center ventilators and intakes at the end, until the load has become thoroughly cooled.

Car under ventilation. — When car is to run under ventilation without ice or heat, the exhaust ventilators on the roof at the center should be open and also the air intakes *at each end of the car*, care being

taken to see that *the hoods at each end face the direction the car is to move.* Air will then be taken in at each end of the car, passed down through the ducts, under and through the lading and out through the ventilators at the center. As each ventilator and air intake has a separate controlling handle or lever, the amount of ventilation required may be obtained by opening one or two ventilators in the center and one or two of the air intakes.

Car under heat. — When the car is to be heated, the valves at each end of the car connected with the drains from the drip pans should be closed. The three-way valve should be set lengthwise with the car and the steam control valve at the side opened. Hose connection is made at either end of the car the same as with passenger equipment.

It is not necessary that the car should have a constant supply of steam by running it next to the engine, *i. e.*, by having connection with steam supply from engine. While the car is being loaded, or after loading, steam connection should be made with a yard steam plug or other steam supply, keeping steam on until the temperature inside of the car is raised to the proper degree according to the kind of freight loaded. The car can then be safely run for twenty-four or more hours without steam. The thermometer at the side of the car will indicate when the car requires more heat.

CHAPTER V.

Additional matter regarding car heaters: Milwaukee heater, Economy heater, Peerless heater and Baxter charcoal heater.

Since submitting the original report, we have had our attention drawn to the following named appliances for artificial heat in cars during cold weather:

The Milwaukee heater. — Constructed on the principle of the oil lamp, with oil reservoir, rectangular in shape, surmounted by a burner and solid metal chimney, with supports for suspending from a ceiling of the car, and with flat the bottom permitting placing on the floor; burns "Headlight" oil, and can be charged to last forty-eight to seventy-two hours, dependent upon supply of oxygen in the car to be heated; two dimensions of wick, namely, 3 inches and 4 inches in diameter. The distinguishing features: 1° metal hood projecting from the chimney near the top radiating and forcing downward the head; 2° rectangular construction of reservoir, permitting location immediately in the corner of the car when suspended, minimizing jars from oscillation; 3° cushion springs as a part of suspensory supports equalizing vertical jars which might extinguish the flame. See cuts below showing heater complete

(fig. 12); also showing the heater in position for lighting suspended in the corner of car (fig. 13).

This heater is made in two capacities, namely; 5 and 6 gallons, and is listed at $15.

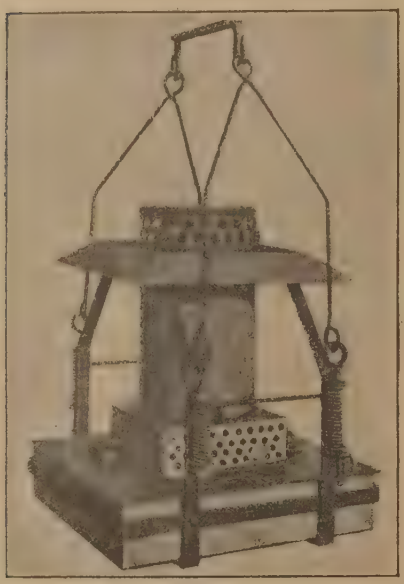

Fig. 12.

Fig. 13.

The Economy heater. — Constructed on the principle of the oil-burning lamp, with circular base and reservoir, surmounted by circular metal chimney; suitable for suspending from the ceiling of cars or placing on the floor; body of heater 17 1/2 inches in diameter, 9 1/2 inches high; metal stack or chimney 7 inches in diameter, 10 inches high; burner 5 inches in diameter, using cylindrical wick; burning head-light oil 150 proof; capacity of oil reservoir 2 gallons, lasting about twenty-four hours; capacity of water reservoir not shown. The distinguishing features : 1° location of reservoir containing water from which water is conducted to a tube 3 inches in diameter inside the burner, intended to cool metal parts and extinguish the flame in case of overturn; 2° construction of baffle plates inside of both water and oil reservoirs preventing the swashing and spilling of liquid. See cuts below showing heater open and closed (figs. 14 and 15).

The Van Evera Peerless heater. — We have not inspected one of these heaters and have only a description indicating that the heater is portable or stationary, and can be located in the car

or under the car; is built for a capacity of thirty-six hours, or more; burners and tanks supported by springs to equalize jolt and jar; tank to be refilled en route, or exchanged for tank filled and ready for use kept at convenient stations en route; construction designed to distribute heat at even temperature to all portions of the car by means of piping securing a greater draft.

Fig. 14.

Fig. 15.

The Baxter charcoal heater. — Designed and patented by W. H. Baxter; circular in construction; 37 inches high by 28 inches diameter; to be located only on the floor of cars; appliance consists of two parts; a magazine or receptical for the fuel (charcoal) with funnel-shaped bottom causing gravity feed; this magazine surmounts a cylindrical fire-box with conical grates and ash pans and provision for passage of air through holes in the sides (fig. 16). A competent authority describes the heater as follows :

A heater designed to burn charcoal and continue operation without attention, for a pre-determined length of time. The degree of temperature is regulated by varying the thickness of fire and not by changing the draft passage areas. This tends to keep a constant temperature which a change in draft would not do so well because the thickness of fire is more constant. The grate and ash-pan are both conical in shape, which insures a proper distribution of the fire and sloping down of ashes clear of the draft passages. The ash-pan will hold ashes of two weeks operation and the magazine (charcoal feeder) has a capacity of fifty to fifty-five hours and possibly sixty hours if the

charcoal is crushed fine enough. This is accomplished by putting it through a common corn-sheller.

Distinguishing features : 1° adjustment to operate for pre-determined length of time by regulating thickness of fire; 2° simplicity of construction eliminating largely risk of injury to heater and contents of car from mal-adjustment; 3° char-

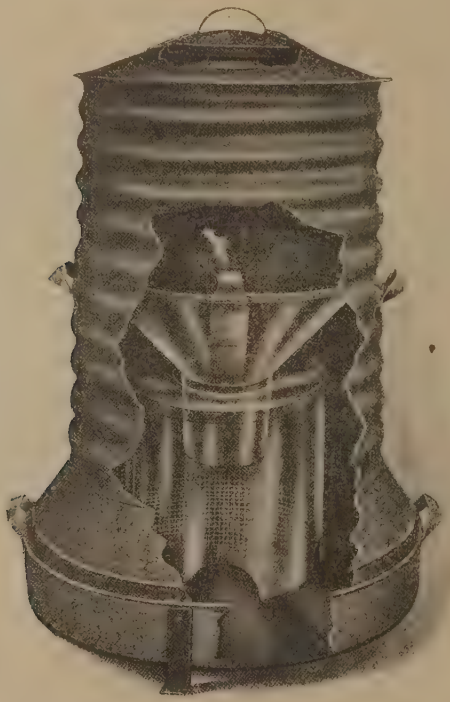

Fig. 16.

coal fuel, eliminating fumes of oil and danger of explosion; 4° automatic extinction of fire if overturned, through solid construction of fuel magazine and tendency of charcoal under ignition to be extinguished when draft is removed. This heater is listed to cost $15 to $20.

We observe that with respect to the oil burning heaters above described, the same have been utilized extensively in certain sections of the United States and have served a useful purpose. The two first described, adaptable either to hang from ceiling or placing on floor of car, the

details which we have explained above, show that in the main the attention needed en route is the same as would be given to an oil-burning illuminating device. On the other hand, actual experience has shown that less attention is required in the case of the Baxter Charcoal Heater, and there is smaller danger of explosion, deleterious odors and gases or damage by fire.

5TH SECTION — LIGHT RAILWAYS

OPENING MEETING

4 July 1910, at 5 p. m.

PROVISIONAL PRESIDENT MR. ERNEST GERARD,
MEMBER OF THE PERMANENT COMMISSION OF THE CONGRESS.

The President. (In French.) — Gentlemen, as I am the temporary president of this meeting, I have the honour to bring before you the proposals which the Permanent Commission has asked me to submit to you, relating to the appointment of the bureau of the 5th section. It is of course understood that you are at liberty to modify these proposals or to supplement them, if for instance you think that it is advisable to increase the number of vice-presidents or of secretaries.

I accordingly propose to you to appoint :

1° As president : Mr. G. BEHRENS, director of the Midland Railway (England), member of the Permanent Commission of the Congress, who is perfectly familiar with the three languages most used in our discussions. (*Applause.*)

2° As vice-presidents : Mr. C. DE BURLET, inspector-general of bridges and roads, general manager of the Belgian National Suburban Railway Company, member of the Permanent Commission of the Congress ; Mr. A. CAMPIGLIO, engineer, president of the Italian Union of railways of local interest and of tramways, director of the Milan Northern Railway, member of the Permanent Commission of the Congress ; and Mr. E. VON ZIFFER, engineer, president of the Lemberg-Czernowitz-Jassy Railway (Austria), who has done distinguished work about sundry questions. (*Applause.*)

If you wish to propose anybody else as vice-president, kindly let me know.

As nobody wishes to speak, I declare the proposals of the Permanent Commission adopted.

Provisionally, only one member has been proposed to act as principal secretary, namely Mr. JESSER, inspector, Austrian Southern Railway Company. Mr. Jesser, who is present, has kindly undertaken thesse duties. (*Applause.*)

Gentlemen, I declare the bureau formed and I vacate the chair which will now be taken by Mr. Behrens, who will

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propose to you the appointment of the other officers of the bureau, namely the secretaries and secretary-reporters

Mr. Behrens. (In French.) — Gentlemen, in taking the chair and thanking you warmly for the honour you have bestowed on me in appointing me to preside over your labours, I wish to claim your kind indulgence if I do not always express myself correctly in French and in German, as English is my real mother-tongue. (*Applause.*)

— On the proposal of the president, the SECTION then appointed the other members of the bureau and drew up provisional agenda.

SECTION V : LIGHT RAILWAYS

[656 .27] QUESTION XVII

LINES BELONGING TO MAIN RAILWAYS BUT HAVING NOT MUCH TRAFFIC

(3rd and 5th SECTIONS MEETING JOINTLY)

Simplification in operating lines belonging to main railways but having not much traffic.

Reporter :

All countries. — Mr. Quarré, chief engineer, assistant traffic manager of the French Midi Railway.

QUESTION XVII

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N. B. — Vide also the separate issue (in red cover) No. 12.

[656 .27]

REPORT

By Mr. QUARRÉ,

CHIEF ENGINEER,

ASSISTANT TRAFFIC MANAGER OF THE FRENCH MIDI RAILWAY.

This question has already been discussed at three previous sessions of the Congress : at Milan in 1887, at St. Petersburg in 1892, and at Washington in 1905; but in neither case was it limited, as now, to lines not having much traffic, but belonging to main railways. On the one hand, it included the examination of the simplifications obtainable on lines of local interest; on the other hand, economic methods applicable even to main lines themselves were considered. Moreover other relative questions were also discussed at different sessions : Rolling stock for lines with little traffic (1892); Relaxation of normal requirements for light railways (1895); Automotor vehicles (1900 and 1905).

Thus all the economic methods of operation known, used or suggested, have already been considered in detail and repeatedly, and for all classes of lines.

When first discussed, this question was very much a question of the day. The development of the secondary or light lines of the trunk systems was already great, and the principles of their construction and operation, which were still the same as those laid down originally for the main lines, involved unnecessary limitations and expenditure all the more felt as the new lines yielded but low returns. It was therefore essential to compare the different investigations made by the administrations interested, with a view to placing the legislative provisions, the regulations and the methods of operation in harmony with the real requirements of the case; and to lay down the simplifications considered admissible by a body of undoubted authority, the decision of which could afterwards be invoked in favour of the modification of rules of excessive strictness.

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This task, vigorously pushed forward, led on the whole to a satisfactory result. A number of countries today possess a light-railway legislation which is sufficiently liberal and which the railway administrations declare is satisfactory. It is true that there are still to be found legislations which do not draw all the distinctions desired between lines of the different classes; but it is easy to ascertain, by comparison with what has been done elsewhere, what improvements can be introduced. On the other hand, the known methods of simplified operation are sufficiently varied and numerous to make it possible to operate economically lower-class lines, in such a way as to satisfy both the requirements of safety and the convenience of the traffic. Thus it certainly seems that the study of the subject is nearly exhausted, as far as generalities are concerned; it can at present hardly consist in more than trying to investigate improvements in points of detail and examining the conditions now existing in the different countries; unless indeed, be it of course understood, some new process or method were evolved in addition.

In 1905, at the Washington Session, Mr. J. Rocca, reporter for all countries except America, Austria-Hungary, Germany and Holland, after remarking that the examination of economic methods of operation for lines not having much traffic (the question then referred to all lines not having much traffic, whether belonging to main railways or not) had already given rise to two important discussions, nevertheless considered it advisable to take up the question anew. It is to be observed that the last time the Congress had considered it was in 1892. On the other hand, Mr. Cornel de Tolnay gave similar information about the other countries, America excepted.

In spite of the ample material provided for discussion, if we refer to the reports of the meetings of the 1905 Congress, we find that no remark, no proposition, was brought forward on the subject of the different simplified methods of operation, and that the discussion at once took the form of an exchange of views on the possibility of running automotor cars on such and such gradients.

There is no doubt that at that time general attention was above all drawn to this subject of automotor cars, which were looked upon as capable of transforming the whole system of operation of light railways (1). This was evidently the only side of the question which led to its retention in the agenda of the Congress.

Be this as it may, and given the state of the question, taking into consideration also the very complete reports presented in 1905, we thought that it would suffice if we noted the particular points or changes which have taken place in this short

(1) We do not forget that certain automotor cars, such as the Belpaire cars, had been in use or had been tried on some lines quite a long time ago; but their use had not become extended. There is no doubt that it was the development of automobilism on highroads and highways which again drew attention to such cars; and in fact the problem could almost be considered a new one, as conditions were very different from what they had been previously. On the one hand, great improvements had been made in certain motors, on the other, there was the possibility that light railways would have to fear the competition of motor-car transport on the public roads.

period of time, paying however particular attention to everything connected with the utilization of automotor cars. With this object in view, we prepared a list of questions (see appendix), which was sent to 152 railway administrations. We received a comparatively large number of answers (68 altogether), but most of them were either purely negative or were limited to the statement that no modification had taken place, since 1905, in the methods of operating lines not having much traffic (1). These answers bear out the statement made above, that there is but little interest in taking up the discussion again, except as regards automotor cars; and as regards these, a larger number of the administrations of main railways have as yet not used them (even experimentally) on their secondary lines.

The field of our investigations was moreover too vast, and the time at our disposal too limited, to enable us to undertake long supplementary enquiries. Where we thought we could find data of some value, we nevertheless tried to obtain them, but such information has remained very incomplete. Thus our report practically only includes the information obtained in direct answer to our list of questions.

On the other hand, we have left out of consideration everything referring to narrow-gauge or electrified lines. The former, although administratively connected, in cases, with main railways, are necessarily operated separately, and enter rather into the class of lines belonging to a secondary system; as regards the latter, very few in number among these we are considering, they would not in any way contribute to a general and comparative examination of the subject, as exceptional causes have led to their electrification and to the peculiarities of their service. We should, moreover, have but few new or interesting particulars to present about these different lines. *A fortiori*, and for similar reasons, we have left out of consideration the particulars relating to railways belonging to any extraordinary class, such as the agricultural district railways known as *pioneer* railways in Australia.

Finally, we should have liked to collate statistical data on the results of operating some of the secondary lines of main railways, either operated according to a special system or by ordinary methods. We have received a certain number of figures, but the different railways have such different methods of accounting, and the information supplied is so incomplete, or in cases so involved, that we have been unable to draw up any instructive comparison. We will therefore limit ourselves, in this connection, to the statement which we shall now make at once, without returning to the subject later on, that there is nothing in any of the documents we have examined, enabling us to conclude anything as to the superiority of any one or other method of economic operation.

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(1) We have received no answers from the administrations of the railways of the following countries : Brazil, Canada, Egypt, Spain, Greece, Mexico, Dutch Indies, Rumania and Servia. As regards the following countries : Argentine Republic, Belgium, Bulgaria, Algiers and Tunis, Norway, Portugal, Sweden and Turkey, the only answers which we received from some of the principal systems, were limited to the statement that there was nothing new or of interest to record.

As our report will form an extension of those presented at the last Session of the Congress, we are naturally led to adopt the classification of the Report presented in 1905 by Mr. Rocca, namely : 1° Legislation; 2° Lines economically operated; 3° Methods of economic operation.

We will consequently examine these different points in succession.

1° Legislation.

In the list which follows, we have only included these countries where legislation has been recently modified. In the case of the others, the state of affairs is the same as in 1905, with the possible exception of those about which we have received no information, their administrations not having answered our list of questions.

We would note that what we are considering here is not the legal phraseology of the concessions, or the administrative, financial or economic laws; what we wish to consider are the laws which distinguish between main lines and lines of a lower order, from the points of view of construction and of operation.

Finally, among such legal provisions we include all acts, decrees, etc., in fact all the orders issued by the superior authorities and which the operating administrations necessarily have to obey.

Germany.

A new *set of regulations on the construction and operation of railways* was issued 4 November 1904, and came into force 1 May 1905; this replaced the older regulations and more especially those concerning secondary railways, which had been in force since 5 July 1892. The principal alterations made in the older regulations are explained in the *explanatory remarks* annexed to the regulations.

Finally, on 1 August 1907, the following came into force : the *signalling regulations*, including the regulations proper, followed by the *executory prescriptions*, and the *prescriptions concerning the train service*. The principal modifications made in the older regulations are also explained in the *explanatory remarks*.

The new texts have been worked out principally from the prescriptions already in force, with some changes of wording to avoid ambiguity, and the matter treated is classified better. The actual innovations made on this occasion are but few in number, and are really only improvements in detail. The prescriptions concerning the train service, and the signalling regulations, do not include, as far as secondary lines are concerned, any alterations worth mentioning.

The regulations of 1 May 1905 authorize having the driver alone on the locomotive of a train; subject to the condition that a guard either comes on to the footplate while the locomotive is running, or that matters are so arranged that he can pass from his van to the cab of the locomotive, while this is running. This is a condition which is met with very frequently, when such an authorization exists.

This arrangement had been recommended, from 1886 onwards, by the technical commission of the German *Verein*, and it had been specified in the *fundamental principles* laid down by the general meeting of the *Verein*; but these *fundamental principles* only formed a common programme, and had no obligatory character.

Under the old secondary-railway regulations, the maximum train-speed authorized was 40 kilometres (24·8 miles) per hour, and this was only allowed in the case of passenger trains equipped with the continuous brake and having not more than 26 axles. It was permissible to add, at the tail of the train, cars not equipped with the continuous brake, but not more than 12 axles. Today, the speed may attain 50 kilometres (31 miles) per hour [1]. As for the maximum number of axles, it is fixed as follows :

80 axles, for speeds not exceeding 30 kilometres (18·6 miles) per hour ;
40 — — between 31 and 40 kilometres (between 19·3 and 24·8 miles) per hour ;
20 — — exceeding 40 kilometres (24·8 miles) per hour.

The two latter limits can even in certain cases be extended to 48 and 30 axles. Moreover, the regulation limits can be exceeded by 2 axles, for every 6-axle car contained in the train ; this provision is intended to promote the adoption of such cars, as their use is considered desirable and as contributing to increased safety.

It is permitted to hang on, at the tail of a train equipped with continuous brake, a greater number of cars not so equipped, than formerly. The maximum fixed for such extra cars is at present as follows :

30 axles, for speeds not exceeding 30 kilometres (18·6 miles) per hour ;
20 — — between 31 and 40 kilometres (between 19·3 and 24·8 miles) per hour.

No car not equipped with the continuous brake may be added to trains having a speed exceeding 40 kilometres (24·8 miles) per hour.

Finally, the brake tables have been revised, as regards the number of brakes the train must have; but the brake principles remain unaltered.

Austria.

The act of 24 December 1905, and that of 29 December 1908, extended the validity of the railway act of 31 December 1894 pending the promulgation of a new act concerning secondary railways.

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(1) But only with the consent of the superior authorities of the country, and with the following restrictions : the cabins at the ends of the sections must be interconnected by telegraph ; the lines must be equipped with alarms or appliances for informing the gatekeepers when trains start ; junction stations must have entrance signals ; the level crossings without gates and not visible from afar, must be guarded when the trains pass ; finally information as to the starting of trains must be given by telegraph, in cases where no block system exists.

New regulations for operating railways of local interest were published, on 11 December 1905, in the form of an order issued by the Ministry of railways, and came into force 1 October 1906. The majority of the fundamental provisions is not affected, but the executory provisions are materially altered.

Signals ordering the drivers to sound their locomotive whistles must be placed near level crossings not provided with gates and placed in unfavourable or frequented portions.

The rules in connection with the coupling and uncoupling of cars have been made less strict. The employees are allowed to go between two cars, if these are moving slowly.

It is not necessary to intercalate a buffer car in the case of trains with speeds not exceeding 45 kilometres (28 miles) per hour (this limit was formerly 25 kilometres [15·5 miles] per hour).

The telephone may be used for transmitting orders and information concerning the train service.

The limits of the speeds of trains at switches, both at stations and on the line in the open, have been modified.

A locomotive may be used to push trains on certain sections, after authorization given by the Ministry of railways. Trains pushed by an extra locomotive (having one locomotive at the head and one at the tail), must not exceed a speed of 30 kilometres (18·6 miles) per hour.

The drivers of all the road locomotives may also act as chief conductors.

One important change in the train service consists in replacing the interval of time, between two successive trains running in the same direction, by an interval of distance (from station to station). No train is allowed to start from any station before information is received from the next station that the preceding train running in the same direction has arrived. This need not be done in the case of lines operated with one locomotive only. When no such information as to arrival can be obtained, a train may not be despatched till after the time normally required by the preceding train for the journey has elapsed, with a minimum of ten minutes. Moreover, in such a case, the driver must receive an order to proceed carefully, going at a sufficiently-low speed to enable him to stop in time in case of any obstruction of the track. Such an order of careful running is however not necessary if it is certain that the track is clear to the next station (for instance, when a train going in the opposite direction has just arrived).

The regular passing-places of trains cannot be altered unless a complete understanding has been arrived at by the stations concerned. The use of bell signals is not sufficient warning.

The cars can be left standing on the open track, for loading or unloading operations, provided the necessary safety measures have been taken. The first train which passes them takes these cars to the sidings of the nearest station.

New bases have been adopted for the braking, specifying the weight to be braked, according to the total weight of the train, the speed and the gradient.

Connecting the wagons by two side chains is no longer necessary. It is permissible to place two wagons without brakes behind the brake van carrying the signals, if the last of these two wagons is equipped with the signals necessary.

Where conditions are favourable, trains can run on lines of local interest not equipped with gates, at a speed of 40 kilometres (24·8 miles) per hour and in certain cases at even greater speed.

In the case of passenger or mixed trains running at speeds exceeding 30 kilometres (18·6 miles) per hour, the locomotive, the luggage vans and the passenger carriages must all be equipped with the continuous brake. When the speed does not exceed 30 kilometres (18·6 miles) per hour, a number of unbraked wagons may be added to such a continuous-brake train. The regulation proportion, of weight braked to total weight, is the same whether the vacuum brake or the hand brake is used. In the case of speeds exceeding 30 kilometres (18·6 miles) per hour, the addition of wagons not equipped with brakes is only authorized if the weight of the vehicles equipped with the air brake is sufficiently great to obtain, for the whole train, the proportion desired. The number of brakesmen is fixed, in accordance with the speed, as shown in the brake tables. When the weight of the wagons equipped with the hand brake only is greater than one fourth of the total weight of the train, the brakesmen are distributed, preferentially, over those parts of the train which are not acted on by the continuous brake.

Hungary.

New regulations on the operation of railways of local interest were issued in 1904, but the alterations are unimportant. An act concerning railways of local interest is in course of preparation, but its chief object is to revise the system under which concessions are granted and the conditions under which they are operated by the State; the principles of operation are to remain the same.

Great Britain.

The only thing we have to record is the answer sent by the management of the Lancashire & Yorkshire Railway, to the effect that fas ar as automotor services are concerned, the Board of Trade has made the provisions referring to the construction of the track and of the buildings, at stopping places between two stations, less strict.

India.

In 1907, the Government of India issued regulations concerning the train services on all the railways. These regulations include no particular provisions tending to simplify the operation of lines having but little traffic.

Australia.

An act modifying the government railways legislation was issued in 1907. The only detail to note is that locomotives are authorized to run tender forwards, whether running light or hauling a train, on district lines.

Italy.

Mr. J. Rocca in 1905 announced that the fundamental act of 20 March 1865, concerning railways, was to undergo a total reform, which would result, in the case of lines with but little traffic, in a profound modification of the act of 9 June 1901. While the latter only conceded certain facilities of operation in exchange for an increase in the number of trains per day and a decrease in the rates, the project which was being prepared included a number of liberal measures (1), applicable as a matter of right to all secondary lines, and even exceptionally to main lines. Mr. Rocca observed, with reason, that the facilities granted, being based on sound technical sense and on the progress made in the science and industry of railways, should not be made a matter of haggling, and sold to the companies at a correspondingly high price.

This reform, which certainly appears justifiable, has not yet been carried out. An act of 30 June 1906 was passed, but this upholds the principles of the act of 9 June 1901. According to the latter, trials of an economic service were authorized on lines or sections of lines of local interest having mean gross receipts not exceeding 10,000 lire per kilometre (£643 per mile) per year; and the corresponding reductions in the rates were to be 30, 35 or 40 per cent respectively, according as these lines yielded per year and per kilometre (per year and per mile), either more than 7,500 lire (£483), or from 5,001 to 7,500 lire (£322 to £483), or less than 5,000 lire (£321).

In the 1906 act, the above limit of 10,000 lire (£643 per mile) was replaced by one of 7,000 lire (£450 per mile) of receipts from passengers, luggage, dogs and bicycles, and the reductions in the rates only apply to these classes of traffic. These reductions are 30, 35 or 40 per cent respectively, according as the receipts in question, per year and per kilometre (per year and per mile), are either greater then 5,000 lire (£321), or between 4,000 and 5,000 lire (between £257 and £321), or less than 4,000 lire (£257).

This latter act is no doubt a slight improvement on that of 1901. It was logical to limit oneself to reductions in the tariffs in the case of the only classes of traffic

(1) Such as : doing away with fencing and with gates at level crossings, except in certain special cases, subject to the condition that the speed of the trains does not exceed 60 kilometres (37·3 miles) per hour, if they are equipped with the continuous brake, and 45 kilometres (28 miles) per hour, if not so equipped; the use of the telephone instead of the telegraph; the inspection of the track once per day.

which could grow in consequence of the conditions imposed, namely an increase in the number of trains. Moreover, this measure eliminated the complications which arose in connection with the goods-traffic accounts.

But the reform expected in 1905 is still far off, and so the anomaly continues to exist, that economic methods, having as their motive the smallness of the traffic, are only admitted subject to conditions tending to develop that traffic, and consequently to make those methods less justifiable.

United States of America.

The only point we have to record is the information supplied by the Central Office of the *Pennsylvania Lines West of Pittsburg*, that the provisions of the laws recently promulgated on the subject of the block system, do not apply to secondary lines on which the passenger receipts are less than a fixed minimum amount.

Switzerland.

An order concerntng the construction and operation of secondary railways was issued 10 March 1906, but it does not contain any simplification of the prescriptions which were then in force.

We had asked whether other laws or regulations, more especially those fixing the conditions and the hours of labour of the employees, and several of which have been issued lately, had any effect on the methods of operation previously adopted. As a general rule, such laws, while materially increasing the expenses of the railways, do not appear to have made it necessary to reorganize the existing services. In the third part of our report, we will however mention one particular measure (closing small stations at certain hours) taken in consequence of such legislation by the French Western Railway (now incorporated in the State system).

The railways of the United States of America complain very generally of the difficulties which arise from the application of the federal law issued 4 March 1908, which limits the hours and fixes the conditions of service of telegraphists, locomotive men and other employees. This law requires, for instance, that there should be a fixed interval between two consecutive runs, so that if a train arrives late at a terminus station, it must in cases start correspondingly late on the return journey, in order to enable its staff to have its legal period of rest (1).

This summary of the recent modifications made in legislation, in the different

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(1) The Union Pacific informs us that this law has increased the expenses on secondary lines by about 10 per cent.

countries, appears to show clearly that a certain settlement in this fundamental part of the question has been arrived at. For very few laws or regulations have appeared during the last five years, and these are mostly coordinations, with variations in the details only, of existing prescriptions. However, most of the administrations in question, who have expressed their opinion on the subject, declare themselves satisfied with the existing state of affairs, which seems to them to be in harmony with a rational operation of the secondary lines of their systems.

We must, however, except the managements of the railways of the United States of America, which differ from what is the more general opinion, and think that the laws and regulations controlling them are much too stringent in the case of minor lines, and quite uselessly increase the cost of working. We think it of interest to quote some of the most striking answers on this point :

Boston & Maine Railroad. — American railroads are at present suffering from too much legislative provision which, while undoubtedly in many cases originating in a desire to rectify obvious faults, owing to lack of proper understanding of railroad conditions, is so framed as to but imperfectly accomplish the end desired while it entails large expense on railroads in complying.

Toledo, St. Louis & Western Railroad and *Chicago & Alton Railroad.* — Drastic legislation has made it impossible to effect any economy in operation of branch lines.

Delaware & Hudson Railway. — The present legislative provisions are obnoxious; less interference by the government in the handling of railroad facilities would save expense and facilitate the operation. The cost of making the reports demanded by national and state laws has alone enormously increased our operating expenses.

We may add that the legislation of the United States does not draw any distinction between main lines and secondary lines, but the railway administrations, taking into consideration the tendencies of the moment, do not show any desire for an alteration in the regulations in force, as they fear that instead of any alleviation there may be an aggravation in the burdens placed on them.

2° Lines economically operated.

In accordance with the preceding reports to which we refer, and although there is no accurate definition of lines economically operated, it is advisable to include, under this head, two kinds of lines :

1° In Italy, those with an *economic service*, specified by the legislation which treats them separately, only authorizing the facilities of operation granted under certain conditions (reduction of rates and increase in the number of trains); this prevents these facilities from being used on other similar lines, reasons of a technical character not entering into consideration;

2° In other countries, those which are classified separately from the neighbouring

lines, and which have a special administrative organization. This usually consists in entrusting their management to one sole manager who looks after all the service, and is only under the control of the central administration of the system. They remain subject to the general rules of technical operation of that system, and there are applied, there as well as elsewhere, different methods of simplified operation which are authorized and made possible by the existing special conditions.

These two classes have not actually, as between themselves, any close relation. The exceptional system of lines with *economic services*, instituted in Italy by the legislation, no doubt makes it evident that these are the object of special study, but in other cases, as regards lines *economically operated*, the real question is the method of simplified operation, the examination of which should, more logically, be dealt with in the subsequent part of our report. It would seem that it is only the similarity of the words which has led to this divison of *economic service* and *economic operation*. Moreover it is really of no importance, and having made this remark we will now continue.

As regards the former lines, the Italian State Railway has, since 1905, only established economic services on the Lecca-Francavilla-Fontana line, and on its Narda-Galatone branch; these were opened in May, 1907.

As regards the others, and excepting the Erie Railroad which has made trials of economic operation, but up till now without success, the railway administrations which already had such methods of economic operation, have simply continued them in those places where adopted, without further developing them; the reason being because they either have not come across new suitable adaptations of such methods, or perhaps because any very definite advantages had been realized in the trials already made. The Orleans Company (France), which had formerly declared that it would extend such methods, applied already to 237 kilometres (147 miles) of its lines, has done nothing in the matter. Similarly, the French Western (now part of the State System) which in 1905 had 1,242 kilometres (772 miles) of economically-operated lines, forming 23 sections, also remained unchanged. It must however be admitted, if we examine its railway system, that it appears to have adopted such methods, from the start, on nearly all the sections which were suitable for such special classification. This company estimated at about 15 per cent the saving in the cost of staff, which resulted from such an organization, but it is evident that this estimate refers to the whole of the measures taken, and not to those which, strictly speaking, constitute economic operation.

This measure is moreover of somewhat limited application, for it is necessary to find, in the first place, a group of minor lines, close together, sufficiently extensive to justify their management by an official of considerable capacity, such as is required for the purpose. Forming such a group also tends to the specialization of the employees, of the rolling stock, etc., and this may occasion difficulties. It

may even be asked if certain economies, either actually realized on those lines, or which are shown by the methods of accounting adopted, are not counterbalanced by increases, less direct and evident, but existing nevertheless, in the general expenses of the railway system.

In any case it must be recognized from the answers which we have received, that the situation, as far as economic operation is concerned, has hardly varied since the last Session of the Congress; and that at present the administrations of the great railways are not actively engaged in this direction in trying to find out how to effect savings in the expenses of their minor lines.

3° Methods of economic operation.

As regards the majority of these methods, such as : doing away with fences and gates at level crossings; doing away with alarms and distant signals, giving stations a limited service only, running shuttle services, having a female staff, reducing the number of passenger classes, etc., the administrations questioned have mostly limited their answers to the statement that they had not recently introduced any material changes in their methods of operation.

The general tone of these answers may be gathered from the following reply given by the Orleans (France) Company :

" No material modification has been instituted, since 1904, in the operation of lines with " little traffic. The former methods : running light trains, shuttle services, giving stations " a limited service, etc , have simply been either extended, or reduced, in accordance with " the variations in the traffic on the lines in question. "

The only actual points, more or less definite, which are noted are the following; they call for no remark and we only quote them for the purpose of being recorded :

The *Austrian Southern Railway* have adopted the normal system of main-line operation on certain local lines connected with main-lines, on which the traffic had grown considerably.

On the line from Steinbruck to the Hungarian frontier, there has been inaugurated, as regards the permanent-way service, a new system consisting in a complete separation of the level-crossing gate-keeper service and the line service. It is proposed to extend this system generally; it is expected that it will cost less and that the track will be looked after better.

The *company operating the Dutch State Railway* has extended its system of economic operation to the following lines : Coevorden to Gasselter-Nyeveen (55 kilometres [34 miles]), Assen to Bladskanaal (27 kilometres [17 miles]), and Marienberg to Almelo (19 kilometres [12 miles]).

The *Danish State Railway* has on one line only, that from Viborg to Herning (opened in 1906), entrusted the service at several stations to a female staff. Shunting operations at these stations are controlled by the train staff.

Finally the *Union Pacific*, in consequence of a great reduction in the traffic, has had to reduce the service on little-frequented lines, to the extent dictated by the circumstances. Trains have, for some time, only been run three times per week. Moreover, on the sections where the passenger traffic has shrunk, the trains have consisted of automotor cars.

This company remarks incidentally that in the United States of America, it is above all the main lines which have had their system of operation improved, by installing the block-system, strengthening the tracks, etc.

The same has also been the case in other countries, owing to the continual growth of the long-distance traffic; and this has no doubt contributed to the lesser attention paid to the service on lines with little traffic. More especially as regards the organization of local trains, with special stock, such as light locomotives and cars or automotors, it is evident that such an organization is rendered much less opportune by the fact that new locomotives and cars are obtained for the important trains, and consequently a number of the older locomotives and cars become available for use on such local lines.

Moreover, as we have already seen, the legislation having changed but very little and the methods of operation being already established, in many cases, in accordance with the facilities granted by such legislation, it is evident that for that reason also these methods were only liable to very limited modification. If in the United States of America, more especially, the stringency of the legislative provisions makes it useless, a priori, to try to find out how to effect savings by means of simplified methods of operation, it may be considered that in other countries the inverse is the case, that is to say there is already a satisfactory operation of lines of this kind.

However that may be, it is certain that if we pass today in detailed review all the methods of economic operation adopted, there would be much repetition. We will therefore only mention the following points, which in the present state of the question have appeared the only ones sufficiently interesting to place on record :

1° Use of the telephone.

The substitution of the telephone for the telegraph is becoming more and more general on the secondary lines. None of the administrations who have allowed this substitution mention that any inconvenience has resulted. This use of the telephone appears really advantageous, whether used by itself or together with the telegraph, according to circumstances.

2° Separation of the passenger and goods services.

The railway administrations have investigated the methods for realizing this separation, in order to make it possible, without excessive expense, to run quicker passenger trains more frequently.

These administrations however recognize that in spite of the new devices for reducing the cost per train-unit : reduction in the train staff, use of light rolling stock, automotor cars, etc., the system of mixed trains still remains in principle the most economic. They moreover consider that this system results in the best utilization of the goods wagons, thus resulting in very definite indirect advantages, which it is however impossible to calculate exactly.

The division of the quick-freight and slow-freight services no doubt tends to increase receipts from passengers, luggage and other accessory items, and consequently to counterbalance the increased expenditure which results, but we have not been informed of any conclusive examples in which this result, economic in the strictest sense of the word, has been attained; and finally it would seem that the considerations which have led to this separation are not the seeking for reduced expenses or increased receipts; it is rather the desire to satisfy the demands of the public, without any corresponding direct gain, to adhere to existing time-tables, to ensure connections with the main-line service, etc.

We will quote some of the answers on this points :

Bavarian State Railway. — The division has been carried out, so as to enable the goods services at smaller road-side stations to be attended to by the train staff, while the train stops at those stations. This system makes it unnecessary to keep a special staff at those stations; moreover, it makes it possible, under suitable conditions, to reduce to a minimum constructive works at the road-side stations of the local railways of recent construction.

This answer does not make it clear whether the solution adopted is economic or not. Moreover, it is to be noted that the results mentioned are obtained even with a service of mixed trains.

Wurtemberg State Railway. — Up to the present, we have not recorded any reduction in working expenses, resulting from the separation of the services. This organization, adopted on some secondary lines, has the object, principally, of enabling the passenger trains to keep to time. This separation has been carried out on some rather long lines with a considerable amount of passenger traffic, principally with a view to the acceleration of the faster trains, and in order at the same time to stimulate the passenger traffic. The working expenses have not been found to be reduced. Operation by mixed trains results in lowering the cost of traction; moreover, it makes it possible to move the wagons more quickly and more frequently, thus increasing the utilization of the rolling stock.

Austrian State Railway. — The separation of the services generally leads to increased expenses, for as there are but few passenger trains, it is impossible to reduce them still further. Under these conditions, every goods train run increases the number of trains by one. Running the latter makes it possible, under certain conditions, to develop the passenger traffic, but no particular economic advantage results. As a rule, separation is only effected if the mixed trains can no longer cope with the goods traffic. This system is also adopted when a line is connected with several foreign lines; this is the case with the local line Rakonitz-Pladen-Petschau, where the stops necessary at the stations resulted in lateness and in the missing of connections.

French State Railway. — The circulation of goods trains, instead of mixed trains, is dictated by considerations of convenience of service, and is generally not connected with the question of the receipts per kilometre.

Orleans Company (France). — We have tried to reduce, on some secondary lines, the number of mixed trains. The separation of the services on those lines appears to us to involve a greater cost of staff and greater general expenses, without appreciable financial gain to counterbalance this.

Paris-Lyons-Mediterranean Railway. — As a rule, the division of these services has not resulted in reduced working expenses. When we adopted this system, it was to improve the passenger service, by accelerating the trains, but such an organization is more rather than less costly.

Midi Railway (France). — Trials of separate services were made formerly, but are now abandoned as being too expensive, and not exercising an appreciable influence on the receipts.

3° The closing of stations or stopping-places at certain hours.

This measure has been adopted, more especially on the French Western Railway (now forming part of the State system), in consequence of the legislation on the conditions and hours of labour of the employees. It is worth mentioning, for when as a matter of fact excessive hours of labour do not result, it makes it possible to manage a station without extra staff, in the morning and in the evening; and at small stations, in between the times at which trains pass, there is no practical inconvenience in closing the stations during given hours, of which the public is duly informed.

4° Reduction in the train staff.

We will limit our examination to the case of a reduction of the number of employees on minor trains (called in the different countries : light trains, tramway trains, stopping trains, secondary trains) to two, only one being on the locomotive. This latter system, although it has now been authorized by a certain number of regulations for some time, is as yet very little applied and many administrations hesitate to adopt it in practice.

The principal reason for this hesitation is no doubt the obligation imposed on the driver to observe the track and the signals continually, but another reason is no doubt to be found in the rules for protecting a train which has stopped on the open track, accidentally. According to certain regulations, such a train must at once be protected at the tail by a train employee, whether the stop is short or long, and in many cases, that employee is not allowed to return to his place in the train, however long the stop may be. It follows from this that a light train, with a staff reduced to two men, is often, from this very fact, made incapable of resuming its journey.

Attempts have been made, in various ways, to overcome this difficulty. Thus, with the system adopted in Germany, and more recently in Austria, that is to say, with a service of trains going in the same direction separated by station-to-station intervals, which really forms a sort of telegraphic or telephonic block-system, it is evidently possible to simplify extensively the rules for protecting the rear of a train. Another system has been selected by the Orleans Company (France). It consists in increasing by fifteen minutes the regulation interval of time between a light train and whatever is the next train; this makes it possible to leave the former unprotected, in the case of any unexpected stop between two stations, during any stop shorter than that increase (1).

Without examining this detail more closely, we will now mention the applications already made by sundry administrations, either in current practice or as an experiment, of the system which consists of having one man on the locomotive only and thus makes it possible to reduce the whole train staff to two men.

Germany.

Alsace-Lorraine Railway. — In certain isolated cases, locomotives are used on which the whole staff consists of one driver only. These locomotives are designed so as to give access to the first car of the train, and arrangements are made so that the train is accompanied by a second employee, capable of driving the locomotive in case of necessity.

On the Bischweiler-Oberhofen line (passenger service only), the driver and fireman also act as conductor and guard, and there is no other employee on the train.

Baden State Railway. — Formerly the tank-locomotives of a local train service running between Carlsruhe and Ettlingen (main line) were managed by a driver alone. The chief conductor had access to the driver's cab, through a door in the back of the tank-locomotive. This system has been given up and there are now two men on each locomotive.

Bavarian State Railway. — By the application of the new regulations of 1 May 1905, there have been instituted, in 1905, on the main lines and in 1906 on the secondary lines,

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(1) Another system which makes it possible to simplify these protective regulations materially, not only as regards a train, but as regards any other obstacle on the line, results from the acceptation of this essential principle, that the line is normally clear after a train has really passed, and up till the time the next train is actually due. This principle can of course only be accepted subject to the condition that no other extra train is despatched on the line, without having notified its times of running to all the employees concerned.

When this rule is accepted, it is not only possible to leave unprotected a train which has stopped on the track, until the moment of arrival on the next train, but also, to create some obstacle (replacing a rail, sundry repairs, etc.) without continually protecting it from a distance; and this results in a material saving in working expenses. It is even possible, under certain conditions, to run over the track, for instance on a tricycle trolley, which facilitates the inspection of the line. This system is in force on the standard-gauge system of the Landes Railway, a system which is of local interest, and as such outside the scope of our report, but which is closely allied with the French Midi Railway. Moreover nothing would prevent the adoption of this system on the secondary lines of main railways.

light trains for local traffic. On the main lines, these trains can only take 60 per cent of the load authorized for the locomotives hauling them; on the secondary lines, the maximum load authorized is 65 tons.

The light trains run at an average speed of 60 kilometres 37·5 miles per hour on the main lines and at one of 40 kilometres (24·8 miles) per hour on the secondary lines.

On the former, they are accompanied by either a driver and a fireman, or by a driver and a chief conductor. In the former case, the fireman carries out the duties of the conductor. This system is still in the experimental stage.

On the secondary lines, the train staff consists of a driver and a chief conductor. Tank-locomotives of recent construction are used, designed for automatic stoking. The chief conductor can, while the train is running, pass from the cars to the locomotive so as to stop it, should the driver become incapable of carrying out his duties (1).

It has also been recognized possible to have only one man on a locomotive, without any special arrangements, if the train load is such a reduced one that it is unnecessary to renew the fuel on the grate too frequently. It is moreover indispensable that the chief conductor should be on the locomotive while it is running, so as to assist the driver by keeping the track under observation, while the driver is engaged in the firing operations. In such a case, neither the locomotive nor the cars require any modification.

Saxon State Railway. – On the secondary standard-gauge line between Frohburg and Kohren (7·8 kilometres [4·8 miles]), which was opened 1 May 1906, the trains are hauled, as an experiment, by locomotives having a driver only, who is assisted, as far as possible, by a train-hand who understands the working of the locomotive sufficiently to be able to stop it. In order to give access from the cars to the locomotive, a passage-way consisting of a movable platform has been established.

Wurtemberg State Railway. — The system has not yet been tried, but experiments are going to be made shortly.

Austria.

Austrian State Railway. — The light locomotives, which are as yet used only to a very limited extent, are managed by a single man, if the following conditions applying also to steam motor cars) are satisfied (2) :

It is a general rule that the management of the boiler or of the engine must not prevent that employee from bringing to bear, on the observation of the track and of the signals, that attention which is required from the driver of a locomotive on which there are two men.

As regards steam engines, the fuel must be supplied automatically, or else matters must be arranged so that the whole of the stoking can be carried out during the stops. Devices which make it necessary to open the fire-door while running may not be used.

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(1) It is to be noted that the Bavarian State Railway is carrying out these experiments on the reduction of the train staff, both as regards automotor cars on their main lines, and as regards light trains, composed of rolling stock of ordinary type, on those lines which have but little traffic.

(2) There are only three locomotives and one steam motor car equipped with a view to being driven by one man only. One of these locomotives is of ancient pattern and is equipped with a simple device for feeding the fire. The other two and the steam motor car are of recent construction and burn oil.

Moreover, on secondary lines, the engine must be so designed that while running it never requires more than momentary attention. All the appliances which the driver has to watch, must be visible to him when he is in the position he occupies when observing the track.

It is indispensable that there should be a means of communication between the locomotive and the cars of a train; or in case of an automotor car, between the driver's compartment, the other compartments and the trailers, if any.

When an automotor car, driven by one single man, is constructed in such a way that the driver cannot observe the track properly when he is in the compartment containing the motor, then the chief conductor, who then has to undertake this observation, must be able to operate the whistle (or the bell), the gear for stopping the motor and the brakes.

As a general rule, in the case of every train hauled by a locomotive driven by one man only, one of the other employees on the train must be acquainted with the duties of a driver.

Austrian Southern Railway. — On the Laibach-Oberlaibach line (11·5 kilometres [7·15 miles]) the locomotive is driven by a single man.

Hungary.

Hungarian State Railway. — Recently trials have even been made with small locomotives equipped with special stoking gear. On the automotor cars, on the other hand, in addition to the driver there is also a fireman or other assistant.

France.

Orleans Railway. — The system is not yet used, but the methods of applying it are being investigated.

State Railway. — In some cases there is one employee only on the locomotive. The design of the rolling stock has been modified so as to enable the conductor, who is in the first car behind the locomotive, to have an easy access to the latter by means of the footboards.

Paris-Lyons-Mediterrancan Railway. — Trials were made, and then given up.

British Colonies.

Central South Africa Government Railways. — The question is being considered and when certain difficulties of minor importance have been overcome, the system will be applied.

5° Use of special stock.

Such stock, whether locomotive or rolling stock, may be merely of ordinary type, but light and specialized for use on a minor line. In other cases, though of current type, it may have some peculiarities : cars with intercommunication, tank-locomotives designed or not designed to be operated by a single man, etc. Finally, the

stock may consist of automotor cars, that is to say, of cars where each car contains both its own engine and all or part of the rolling stock forming a train; in this class we may include the motor luggage-vans.

We will not repeat the arguments, often advanced, as to the advantages or disadvantages of specializing the rolling stock and of utilizing given cars, designed especially for a given service, on a secondary line or group of secondary lines. A very complete summary of them is to be found in the report of Mr. Sigismond Adeles on the rolling stock of lines with little traffic (1892 session).

In accordance with the plan we have set ourselves, we will only note the alterations since the last session of the Congress. With this object in view, and referring to the information given above as to the scheme of reducing the total number of train men to a minimum of two, we have nothing new of any importance to record, except as far as automotor cars are concerned. This could hardly be otherwise, as it is just with such cars that attempts have been made to improve local services.

That is therefore the only point to which we can attach importance, and we will only refer incidentally, or by way of comparison with the automotor cars, to the matters concerning light locomotives and carriages.

In the summary which follows, we only include those administrations who informed us that their stock for lines with little traffic included automotor cars, and that they had since 1905 more or less modified their system of operation by the use of such cars.

Although we deal exclusively with such lines, we have also referred to the use of such cars on other sections, particularly when any interesting general information resulted from such cases, or when the services organized were operated both on main lines and on secondary sections. Moreover in the case of certain answers, it was difficult to avoid confusion and to disentangle what applied to local lines only.

Finally, it is evident that we have not tried to describe in detail the types adopted, as this would have trenched on question XII (IV of the 3rd section) of the 1910 Congress, which more especially deals with the subject of automotor cars.

Germany.

Bavarian State Railway. — Several automotor cars are running, *but chiefly on main lines :* several suburban trains, on lines running out of Munich, consist of automotor cars.

At first, rather a considerable number of such cars had been put in use, but it was necessary to give them up because it was too often necessary to substitute trains hauled by locomotives. It may be stated, generally, that the automotor cars are laid up for maintenance or repairs during a considerable number of days; they are more frequently laid up than other stock.

Wurtemberg State Railway. — Leaving out of consideration a small narrow-gauge line, on which all the trains are composed of a steam automotor car, with or without

trailers, the Wurtemberg State Railway owns, for use on nineteen of their standard-gauge lines or branches, thirteen steam automotor cars (eleven running and two as reserve), and four benzene automotor cars (three running and one as reserve); but *these run nearly only on main lines.* When an automotor train runs on such a line, it simply continues on a branch line, when this continuation can be conveniently included in the run and no other rolling stock is required. There is only one daily run, in each direction, which is effected by one of the benzene automotor cars, and that is on a branch line, 16 kilometres (10 miles) long, starting from Lentkirch. In the case of steam automotor cars, these are only to be found on one section, 6 kilometres (3·7 miles) long, of the line from Plochingen to Kirchheim (five trips daily in each direction), and on the line from Reutlingen to Pfullingen, 5 kilometres (3 miles) long (two trips daily in each direction).

The Wurtemberg State Railway possesses altogether eleven secondary standard-gauge lines and five narrow-gauge lines.

The benzene automotor cars run without trailers and are only used in cases where there is very little traffic. They provide sitting accommodation for forty four passengers and standing room for eight, and there is no luggage compartment. The steam automotor cars are of two different patterns : one provides sitting accommodation for forty passengers and standing room for eight, and there is no luggage compartment; the other provides sitting accommodation for thirty-two passengers and standing room for four, and also has a small luggage compartment which can be converted into a passenger compartment with eight seats. It is the latter which are to be found on secondary lines. The automotor cars can take three trailers as a maximum, on certain runs. With two trailers, each with forty-four seats, they attain a speed of 50 kilometres (31 miles) per hour on the flat and one of 25 kilometres (15·5 miles) per hour on a gradient of 10 per mil.

During the working year 1906-1907, the steam automotor cars, taking main and secondary lines together, had to do an average daily run of 156 kilometres (85 miles) (maximum, 200 kilometres [124 miles]; minimum, 100 kilometres [62 miles]); and the benzene motor cars, one of 170 kilometres (106 miles) (maximum, 282 kilometres [175 miles]; minimum, 128 kilometres [80 miles]).

The stop which is necessary between two consecutive journeys, can be very short. The benzene automotor cars are always ready to start. The grate of the steam automotor cars is, as a rule, only cleaned out once, before the start, and keeping the engine in working order only necessitates one stop per day, in order to take in water; a supply of water is only required twice a day.

The whole service is never operated by means of automotor cars only; these only run in between the other trains. As there are only three reserve automotor cars, at Saulgau, Friedrichshafen and Tübingen respectively, it is necessary to substitute, the case arising, trains with locomotives; but as it is generally known in advance on what days there will be much traffic, those days are utilized for washing out the boilers and doing any repairs.

During the year 1906-1907, each of the twelve steam automotor cars which were then owned (there was no reserve) ran, on the average, on 204 days (maximum, 306 days), and the benzene automotor cars each ran, on the average, 195 days. Although these figures would appear to show that the automotor stock was laid up rather frequently, the administration of the Wurtemberg State Railway does not think that automotor stock is laid up more frequently than ordinary stock.

Finally, the management declares itself satisfied with this organization and considers it economic.

Austria.

Austrian State Railway. — Actually only two steam automotor cars, on the Komarek system, are used on the local lines Laun-Libochowitz and Cercan-Modran. Up to 1907, another steam automotor car, on the Komarek system, was run on the Wels local line, but is no longer used now.

The automotor cars are only used conjointly with ordinary trains. There is no reserve, and whenever necessary, trains with locomotives are substituted for the automotor cars.

The two automotor cars in use each have accommodation for eight second-class passengers, and for twenty-four third-class passengers, and also a luggage compartment, which can accomodate five passengers. They are reserved exclusively for the carriage of passengers and luggage. A trailer may be added.

Their regulation daily run was, in 1906 and 1907, 112 kilometres (70 miles) in the one case and 107 and 152 kilometres (82 miles) respectively in the other. They actually ran, on the average per day : the first 84 kilometres (52 miles) in 1906 and 65 kilometres (40 miles) in 1907 : the second 77 kilometres (48 miles) in 1906 and 82 kilometres (51 miles) in 1907. This represents a coefficient of utilization varying between 62 and 75 per cent.

These cars, when running by themselves, can attain speeds of 50 kilometres (31 miles) per hour on gradients of 9 per mil, and about 27 kilometres (17 miles) per hour on gradients of 25 per mil ; and if hauling a trailer weighing 10 tons, speeds of 30 kilometres (31 miles) per hour on gradients of 6 per mil and 25 kilometres (15 5 miles) per hour on gradients of 20 per mil.

If we take all the steam automotor cars into consideration, both on local lines as well as on main lines, the stop necessary between two consecutive journeys differs considerably ; it varies between 5 and 30 minutes.

When the automotor cars were first run, it was frequently necessary to substitute ordinary trains. It is evident that this entailed extra expense, so that the automotor cars did not give very brilliant financial results. It is true that these disadvantages have gradually been reduced, as more and more improvements were introduced in the construction of the motors.

Austrian Southern Railway. — On the one line from Barcs to Slatina, a steam automotor car runs 90 kilometres (56 miles) per day. One car is running regularly and there is another as reserve.

Each contains nine second-class and twenty-five third-class seats, and standing room for six passengers. They run normally with a trailer ; the gross weight of the train is 30 to 35 tons and the maximum speed on the flat is 45 kilometres (28 miles) per hour. The steepest gradient on which the automotor car can run by itself is 30 per mil.

The stop between two successive journeys is at least 30 minutes long.

The automotor cars often have to be replaced. They were laid up for repairs 116 days per year on the average, or 31·7 per cent of the time. This ratio is 21·6 per cent in the case of locomotives.

Hungary.

Among the railways of local interest operated by the State, there are thirteen operated by steam automotor cars since the end of 1907. There are twenty-two such cars; they are equipped with de Dion-Bouton motors. Normally they haul one trailer, and exceptionally two. There is accommodation for from 100 to 120 passengers. The maximum weight of a train is 40 tons. Taking into consideration the number of cars usually running, there is a reserve of about 30 per cent.

The average distance run by each car is about 30,000 kilometres (18,600 miles) per year. The shortest stop between two consecutive journeys is thirty to forty minutes.

When there is a sudden rush of traffic, trains with locomotives are substituted for the automotor cars. It often happens that such substitution is necessary, and this exercises an unfavourable effect on the results of this system of working. On the average, each automotor cars runs on about 180 days of the year.

It is to be noted that these automotor cars are driven by two employees, a driver and a fireman or motorman; but on the small locomotives which have lately been introduced and which are equipped with stoking gear, there is only one employee.

The matter is still in the experimental stage (1).

United States of America.

Among all the administrations which have sent us answers, there is only one, the *Union Pacific*, which owns automotor cars; and it declares that it is very satisfied with their working.

The following is a summary of the information supplied by that administration :

Nine cars with gazoline motors are in use and thirty-two more are being built. The first was constructed as an experiment. It has two axles and its weight is about 20 tons. It began, in August 1905, a regular service between Kearney and Callaway (Nebraska) and makes each day a trip in each direction (distance, 65 miles).

The others are on bogies, and have 6-cylinder gazoline motors, the power varying between 100 and 250 horse-power; their total length is about 17 metres (56 feet). They can carry from 57 to 80 passengers. They are built entirely of steel; the front is tapered off to form a wind-cutter, the roof is arched and the end is rounded off.

They are designed for high speeds, and can run up to 104 kilometres (64·6 miles) per hour.

In a few cases they run by themselves, but as a rule they haul a trailer which is intended for luggage, mails and express packages.

Their average daily run is 99 miles. Of the nine cars, three act as reserve.

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(1) According to the most recent information, the Hungarian State Railway is now utilizing automotor cars on fifteen lines (we were unable to ascertain on what class of lines). On thirteen of these lines there are steam automotor cars; the power of the motors varies between 35 and 80 horse-power. There are fifty-two automotor cars available; fourteen of them serve as reserve and five are used for extra or special trains. On the other two lines there are petrol-electric cars, on the de Dion-Bouton system; on the one there are three automotor cars running, with one as reserve (power of the motors, 70 horse-power), on the other, there are two automotor cars, of 25 horse-power each.

If there is a rush of traffic, other trailers are hung on and it very rarely becomes necessary to substitute for them trains with locomotives.

The mean number of days on which they run is 25 per month; they are not laid up more frequently than other vehicles.

No change has been introduced, in consequence, in the general working regulations. Two automotor trains are run each day in each direction. Slow-freight packages and part of the quick-freight packages are conveyed by trains hauled by locomotives.

The staff on these automotor trains has been reduced from four to two men. The four men were paid 365 dollars £73 per month, and the two men replacing them only receive 170 dollars (£34) per month.

Taking it altogether, this organization, which has been extended to 40 per cent of the secondary lines, is on the one hand very economical, and on the other is much appreciated by the passengers.

We should have liked to obtain particulars of the conditions and of the traffic of the different separate lines or groups of lines on which this system of operation is in use, but we have been unable to obtain useful details on these points.

It may be noted, it is true, that the cost of staff was high and the cost of materials, tools and fuel comparatively low, so that it was possible to adopt gazoline motors of high power; thus there were very favourable conditions, which might be lacking in other countries. But it may be asked why other railways in the United States of America have not tried similar methods.

France.

Orleans Railway. — The Orleans Company is running steam automotor cars, on the Purrey system, on several secondary lines; but here is not a case where they are used not for light traffic only but also on lines with an ordinary amount of traffic (Vierzon to Bourges).

These cars are used on isolated sections, but these are grouped around four centres: Tours, La Flèche, Bourges and Le Blanc. They provide accommodation for fifty-five passengers, twenty-five first-class and thirty third-class, have a luggage compartment (10 square metres [108 square feet]) and a half-compartment for mails.

They are used either by themselves, or with one or at most two trailers: passenger carriages or luggage vans or parcels vans.

The daily runs are: at Bourges, 101 kilometres (63 miles); at La Flèche, 104 kilometres (65 miles); at Le Blanc, 115 kilometres (71 miles); at Tours, 220 kilometres (137 miles) (with two shifts of men).

They must stop at least one hour and a half at the station, after running 80 kilometres (50 miles) as maximum, so as to enable the grates so be cleaned out and the fires to be started afresh. This time must be extended to two hours at the terminus stations where the driver alone has to attend to the different operations, such as turning round the car, attending to it and preparing it for the return journey.

After running 30 to 40 kilometres (18 to 25 miles) as a maximum, it is possible to run the same distance over again, without completely drawing the fires and lighting up again, subject to the condition that the stop does not exceed from twenty to twenty-five minutes.

If the stop is to be longer, it is better to start the fires afresh, and then we again have the former case of a stop of at least one hour and a half or two hours.

The Orleans Company has nine automotor cars running and four as reserve, two of which consist of a motor truck only.

The number of reserve cars can probably be reduced in the future, when it is more definitely ascertained how many cars are really required.

The automotor cars must occasionally, in cases of a sudden rush of traffic, be replaced by ordinary trains. The increased expenditure which then results reduces the advantages obtained by means of the automotor cars. Each car is on the average laid up 93 days per year, or 25 per cent of the time. The average time the ordinary passenger locomotives at the stations where the cars are placed) are laid up is about 60 days per year, or 16 per cent.

The use of these automotor cars on lines with little traffic is as yet too recent to make it possible to give a definite opinion as to their merits.

French Northern Railway. — The French Northern Railway has made several trials of automotor cars. In 1895, it tried an electric car, with accumulators, with sitting accommodation for twelve first-class and thirty third-class passengers, standing room for sixteen passengers and a luggage compartment. In 1896, it built another electric car intended chiefly for mails, but also having sitting accommodation for twelve second-class passengers, and capable of hauling one or two passenger carriages. This car was then altered and trials were made with it, in 1901 on the line between Creil and Beaumont.

A steam automotor car, on the Serpollet system, was set running in 1897 on the Creil-Beauvais line.

A second steam automotor car was built at the same period, for suburban service. This consisted of three parts : in the middle, the driver's compartment, the boiler, the engine, and a small luggage compartment which could if necessary be converted into a third-class compartment for six passengers ; at one end, a third-class section ; at the other end a composite first-second class section. Altogether there was room for 82 passengers.

At present, the company is starting, as and when they are delivered, a series of eight cars of this type. These are at present being tried, provisionally and until sufficient experience has been obtained to prove that they can be depended on for definite suburban trains, for services where there is but little traffic. But they are already not considered as special stock for lines with little traffic only.

State Railway. — The State Railway some years ago tried two automotor cars, on the Purrey system, for the Bordeaux suburban service, between Bordeaux and St. André de Cubzac. It was not possible to carry out a continuous and regular service with them ; and they have now been stopped in order to be reconstructed. The administration of the State Railway is not able to give any definite information as to what will be done with them in the future.

On the other hand, this administration has given up the use of the locomotive-luggage-vans which had been built a certain number of years ago. This type of car had seemed very satisfactory as regards the desideratum of having the chief conductor and the driver who alone attended to the motor, close together, but the luggage-van space available had been too limited. At present, if it is desirable to design special stock for lines with little

traffic, the State Railway would seem to prefer small locomotives, capable of being driven by one man only, and light carriages.

Midi Railway. — The Board of Public Works has strongly recommended the French railway companies to adopt automotor cars on the secondary lines. In answer to one of these recommendations, the Midi Railway submitted, in January 1907, the following remarks which we think it will be of interest to reproduce here :

" From the point of view of the organization itself of the service, it is evidently of little " importance whether a train consists of an automotor car with or without trailer, or of a " light locomotive only hauling one or two carriages of ordinary pattern.

" In the absence of automotor cars and as a first experiment, we tried to operate two " of our lines, Carmaux-Rodez and Quillan-Rivesaltes, which seemed to us suitable for " the purpose, by means of tramway trains, which could very simply have been replaced " later on by automotor trains.

" This system has now been working for more than two years on the Carmaux-Rodez " line and for more than one year on the Quillan-Rivesaltes line. On the former, where " two tramway trains and two ordinary trains ran each day in each direction, the two " former had almost at once to be replaced by ordinary trains on Saturdays and on the " Rodez market-days; and also, during summer, on all Sundays, owing to the large num- " ber of tourists visiting the Viaur viaduct.

" On the Quillan-Rivesaltes line, there were also two tramway trains and two ordinary " trains each day in each direction; here one of the tramway trains had to be replaced by " an ordinary train during the whole grape season, that is during more than one month. " The same measure had to be taken on the Perpignan feast and market days.

" In spite of this, we have received numerous complaints in connection with the restric- " tions, on these tramway trains, to the admission of passengers, luggage and parcels.

" The difficulties which resulted from having to substitute ordinary trains for the " tramway trains would have been still more serious if automotor cars had been used.

" These difficulties, which as a matter of fact we had foreseen when we proceeded to " this special organization adopted on the Carmaux-Rodez and Quillan-Rivesaltes lines, " would arise everywhere else, on all of our other lines on which services or automotor " trains could be organized; they would even no doubt be more marked, as we natu- " rally selected, in the first place, those lines which seemed to us most suitable for such " experiments.

" It cannot be denied that the use of automotor cars is no longer practical, if it postu- " lates the necessity of having specially, and always, an ordinary train in reserve to deal " with sudden rushes of traffic on certain days.

" We may add that as the automotor cars are liable to numerous break-downs, their use " cannot be advisable except on lines near depots and workshops and grouped around one " centre, so that there need not necessarily be two automotor cars for each car that is " running, the second acting as reserve to ensure the running of the train in question. " Now on our railway system we have no points where all these different conditions apply.

" Taking it altogether, the experiments which we tried and which, as far as carrying " the traffic was concerned, exactly correspond with what would have resulted if auto- " motor cars had been used, gave but very mediocre results, giving but little encourage- " ment to the undertaking of other experiments of a similar kind.

" We therefore think, that taking into consideration the position, the conditions and the " circumstances in connection with our secondary lines, any improvement in the service " on these lines is not likely to result, at all events at present, from the use of automotor " cars."

In addition, a Purrey automotor car was tried in 1908 on the Bordeaux-Arcachon line, for suburban traffic; thus it was not a question of a line with little traffic. The experiment was given up, as the traffic varied so much that it was too frequently necessary to substitute an ordinary train for the automotor-car.

Paris-Lyons-Mediterranean Railway. — This company owns several automotor cars for use on isolated sections with little traffic. It has tried to group the automotor cars at points sufficiently near each other, but has not quite succeeded in doing so, on account of the difficulty of finding, in one and the same district, lines suited to such a system of operation.

It actually owns automotor cars of two types, both with steam motors on the Purrey system. In the first type the boiler and engine are carried on the underframe of the car itself; in the second, the boiler and engine are on a truck separate from the body of the car. The company has six cars of the first type and twelve of the second.

The cars of the first type have no luggage compartment. The motors are of from 130 to 140 horse-power. There is room for from ten to twelve first-class and from thirty-six to forty-one third class passengers, standing room for twelve on a platform included. The tare is 19 or 20 tons, and the weight when fully loaded, about 24 to 26 tons.

In the second type, the motors are of 150 horse-power, the tare is 30 tons and the weight, when fully loaded about 36 tons. There is room for twelve first-class and forty-seven third-class passengers, a compartment for mails and a compartment for luggage.

The original plan was that these cars should normally run without trailers. However a trailer is now added and in some cases a luggage van or goods wagon.

These cars run as follows :

—	Daily run.	Number of automotor cars running.
Alais to Ardoise	116 kilometres (72 miles).	1
Lunel to Sommières	91·8 — (57 —).	1
Uzès to Nozières	75·6 — (47 —).	1
Arcy-la-Tour to Gilly	85 — (52·8 —).	1
Beaune to Allerey	106·2 — (66 —).	1
Dôle to Poligny	119·1 — (74 —).	2
Mouchard to Salins	148 — (92 —).	1
Montbéliard to St. Hyppolyte	127·2 — (79 —).	2

When it is necessary to have two automotor cars at one point, there is generally one in addition, as reserve.

The minimum length of stop is as a rule dependent on the station installations and limited to the operations of turning the cars, taking in fresh supplies and attending to the engine; it varies on the different lines and on the length of the journey made.

In certain cases, the use of automotor cars has made it necessary to incur expense in the installation of turntables.

As a rule, the cars and ordinary trains run concurrently.

The fact that on days when there is a rush of traffic, the seautomotor cars have to be replaced by ordinary trains, materially reduces the advantages of this stock.

The Company states in conclusion that this organization has now existedbut a short time, and that at present it is still in the experimental stage, The automotor cars have not run sufficiently regularly to make it possible to give any reliable information as to the economic results given by this system.

Great Britain and Ireland.

Great Central Railway. — This company, for the service on some lines with little traffic, has three automotor cars proper, that is to say, cars containing their machinery. They are steam cars, with vertical-tube boilers carried on one of the bogies of the car.

A fourth automotor car owned by this company is really a bogie carriage coupled up with a small tank-locomotive, so arranged that the engine is always at the same end of the carriage, no matter which direction it is running in. The regulator, the reversing gear, the vacuum brake and the steam whistle, can be operated from a driver's compartment located at the other end of the car, whenever this is pushed by the locomotive.

These automotor cars are used with one or two trailers. They accommodate, according to type, from twelve to sixteen first-class and thirty-six to forty-eight third-class passengers, and have a luggage compartment.

Each of these cars is ordinarily running on the lines Barton to New Holland, Wrexham to Brymbo, Woodford to Banbury, Aylesbury to Verney, and there is no reserve. The service is operated on all these lines conjointly with trains hauled by steam-locomotives and when it is necessary, the automotor cars are replaced by ordinary trains.

As an example, we will take the car running on the Aylesbury-Verney line, which is satisfactory from the point of working; but allowing for the days on which it was not wanted, it was laid up 43 times to 270 days of work. It is thus evident that these automotor cars have to be laid up, for maintenance and repairs, more frequently than locomotives of the current types.

The use of these automotor cars does not seem to be very economical.

Lancashire & Yorkshire Railway. — On some of the branch lines, automotor cars are used consisting of a steam-locomotive joined to the carriage body and forming one combined vehicle. The weight of the motor, carried on bogies, is 14·5 tons empty and 16·5 tons in working order; the total weight of the car, loaded, is about 45 tons.

These cars provide accommodation for fifty-six third-class passengers. The luggage compartment has a capacity of 340 cubic feet. They run with a trailer, sometimes with horse-boxes containing horses, sometimes with a loaded goods wagon.

They only stop, between two consecutive journeys, during the time necessary for taking in water.

One or two automotor cars are required for the service, according to line. There is no reserve car. When required, a trailer is added, or else a train with locomotive is run.

The automotor cars are not laid up more frequently than other stock and their use is considered to be economical.

The lines on which they run have a total length of about 22 miles. The gradients vary between 1 in 50 and 1 in 90.

Midland Railway. — The Midland Railway, which has also electrified a part of its system, owns thirteen steam automotor cars : four with the engine at the head of the car, and nine with the engine inside the car.

These automotor cars run with one or two trailers. There is a small luggage compartment. They accommodate fifty-five passengers, all of the same class, and each trailer takes fifty-four passengers.

The distance run per day varies greatly. No minimum duration of stop between two consecutive journeys is fixed.

The automotor cars are used separately on their respective lines (1); there is no reserve If necessary, ordinary trains with locomotives are substituted.

These trials have been begun too recently to make it as yet possible to give any information as to the economical value of this stock.

British Colonies. — Empire of India.

East Indian Railway. — This company owns one steam automotor car, which runs between Agra and Tindla (Delhi district); but when the Patna-Gya line is completed, it is intended to operate a service there with another automotor car, conjointly with mixed trains.

The automotor car, which is on bogies, contains one first-class compartment (for 6 passengers), one third-class compartment (for 68 passengers) and a luggage compartment.

There is no trailer and it is only used to supplement a mixed-train service. Its daily run is 97 miles.

At present, this is only an experiment begun too recently to have any opinion as to its value.

The car is sent every ten days to Tindla to be overhauled. While it is laid up, the service is operated by a train consisting of a first-second class composite, a third-class carriage and a luggage van.

North Western Railway. — A steam automotor car, on bogies, tare about 20 tons, makes each day four runs of 1 hour 17 minutes each (distance, 27 miles), on a minor line. There

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(1) Trent and Stanton Gate; Derby and Wirksworth; Derby and Ripley; Derby and Melbourne; Hemel-Hempstead and Harpenden; St. Albans and Luton; Bedford and Hitchin; Bedford and Northampton; Sheffield and Doncaster; Sheffield and Barnsley.

is a driver and a fireman (1). The car will take five first-class, five second-class and seventy-two third-class passengers.

This is only used for a supplementary passenger service. If necessary, an ordinary locomotive is substituted. It is certain that this substitution involves additional expense. The car is more frequently laid up than the ordinary stock; yet if we compare the receipts and expenses per train-mile, the result does not appear unsatisfactory.

Madras and Southern Mahratta Railway. — As an experiment, three steam automotor cars are being run, but on a main line. Each takes eighty-four passengers and can haul one or at most two trailers, so that a whole train can take 204 passengers.

British Colonies. — South Africa.

Central South African Railways. — Automotor cars are already running on two sections of the main line. The subject is now under investigation as far as secondary lines are concerned, on which automotor cars are going to be used before long.

Italy.

State Railway. — The system does not include lines on which passenger traffic can be conveniently carried by automotor cars only. The latter are more frequently to be found on lines of medium importance, where they run in between trains hauled by locomotives.

One trial only had been made between Cecina and Volterra, but it had to be given up owing to the difficulties which arose in consequence of the quality of the feed-water, difficulties all the more marked as the automotor boilers generally work at a higher pressure than locomotive boilers.

Nevertheless the question of organizing passenger train services by means of automotor cars, exclusively, is again under examination, in other cases which seem more suitable.

The automotor cars always haul light trailers, the number varying from two to four. The average daily run varies between 90 and 120 kilometres (between 56 to 75 miles). The shortest time of stop between two consecutive journeys is thirty minutes.

As the automotor cars, particularly at first, required more careful and more frequent maintenance than other stock, it was advisable to have a sufficiently large reserve. The proportion may be estimated at about one fourth.

Generally speaking, the automotor cars require repair more frequently than locomotives. The difficulties arising from replacing them by ordinary stock have up to the present prevented the extensive use of such stock for the operation of secondary lines.

In conclusion, and until more complete results are obtained, it may be stated that a service of automotor cars only, taking into consideration the condition of the lines and the variations in the passenger traffic, is not suitable unless the conditions are exceptionally favourable.

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(1) On this railway system, there are three men on the locomotive: a driver, a fireman and an assistant to handle the coal. The same is the case on the other railway systems in the Empire of India; but at present trials are being made of having on the light locomotives two men only, driver and fireman.

Although this information is incomplete and rather heterogeneous, it nevertheless conveys a distinct impression that automotor cars have not been so successful as was expected some years ago, when there was a feeling that one was in the presence of a new evolution in the organization of passenger trains on secondary lines.

Mr. Cornel de Tolnay, in the report which he presented at the Washington Session of the Congress (1), quotes the opinion of an expert on the subject (2), who had recommended the system of separating passenger and goods trains, on minor lines, and had expressed himself as follows : " In order that this system may not cause any financial loss to the undertaking, it is necessary for the traction system to be modified radically. The steam-locomotive must disappear from passenger trains." Mr. Cornel de Tolnay added, it is true, that he did not quite share this opinion, which was perhaps a little hard on the locomotive.

Mr. J. Rocca finishes his report, drawn up in July 1904 (3), as follows :

" We think that the true solution of the organization of a cheap service on lines which carry little traffic will be found in the proper use of suitable automotor cars."

The experience of the last five years shows that too much was certainly expected from these cars.

In 1905, the problem of the automotor cars was still in the hands of the rolling stock and locomotive departments of the railways, for matters were still in an experimental stage; only isolated units were running, and these had been started principally in order to ascertain the cost of their working and the technical value of their design. This part of the problem, which required all the ingenuity of technicians to the highest degree, can be regarded as solved by now; perhaps the excellence and the originality of the patterns worked out even contributed to the optimism with which automotor cars were regarded.

It must be remembered that the original project of operation included essentially small trains, of a minimum dead weight, with engines of low power, better suited than steam-locomotives to the tractive effort required; moreover, as far as possible not more than one man should be required for driving any such engine.

When considering a given small amount of traffic, it was evident that the engine could be very small, of such dimensions that it was necessary to have a larger vehicle to contain it. It was in this way that the first conception of the automotor car arose; the type so designed is very useful and very advantageous as compared with ordinary rolling stock.

But as soon as it became necessary to construct more powerful motors, which normally required several axles for their support, it becomes less apparent why the

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(1) Vide *Bulletin of the Railway Congress*, No. 3, February, 1905 (2nd part), p. 797, and *Proceedings of the seventh session* (Washington, 1905), vol. 3, p. XIX-49.

(2) Alfred Birk, *Der Betrieb der Lokalbahnen*. Wiesbaden, 1900.

(3) Vide *Bulletin of the Railway Congress*, No. 12, December, 1904, p. 1839, and *Proceedings of the seventh session* (Washington, 1905), vol. 3, p. XIX-3.

combined form of the automotor car was retained, which was by no means one of the essential conditions of the proposed project. Such a combination, even if slightly reducing the dead weight, on the other hand involved many difficulties. In starting in this way, that is to say in taking as basis the type of the automotor car, it was necessary to get all the constituent parts of the motor into as small a space as possible; and this, in spite of the ingenuity of the devices invented, could not but result in making these parts more delicate, more difficult to handle and to maintain. Combining the two separate parts, the motor and the body of the carriage, into one, also necessarily increases the time the car is laid up, as whenever one requires repair the other can also not be used.

Attempts have been made to overcome this latter disadvantage by mounting the motors on interchangeable trucks, easy to detach from the body of the carriage; but this does not alter the fact that the coupling up cannot be effected with any vehicle, but only with one special type of body, designed for the purpose; so that the number of interchangeable units necessarily remains limited.

As a matter of fact, the information supplied shows that, as a rule, the automotor cars have to be laid up more frequently than ordinary rolling stock, for examination, cleaning and repairs.

But the same information shows that the most serious defect of the automotor cars is their want of flexibility; they are unable to meet, from day to day, the requirements of a varying traffic, and so it becomes frequently necessary to replace them by locomotives and ordinary carriages. That is a practical point which perhaps escaped attention at the start, and was not considered by designers who each worked out types suited to their theoretical traffic requirements, which were fixed and definite in character.

We cannot assume, as our hypothesis, that as soon as there is a certain amount of traffic or as soon as there are rather considerable variations on lines constructed and operated economically, there should be an increased circulation of small-capacity automotor cars, for the original conditions of construction and operation limit absolutely the number of units which can be run per day. One is then often forced to adopt cars of greater capacity, with motors carried on several axles, which in fact become comparable with light locomotives, and are in sundry respects inferior to the latter; thus the advantages of the best type of automotor car are lost. It may be incidentally remarked that with the speeds usually adopted on the lines which we are considering, it is not of much importance, from the point of view of tractive resistance, whether we have several vehicles coupled up together or whether we have them combined so as to form one large vehicle.

It is also to be noted that as regards certain types of automotor cars it was desired to be able to run in either direction, without any necessity for turning the car round at the end of its journey, but this turning can equally well be avoided with small locomotives; the difficulties of construction appear in fact even greater in the former case than in the latter.

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Finally, as regards having one man only to drive the motors, this is certainly an advantage offered by petrol-motor cars; but these, leaving exceptional cases out of consideration, belong to the class of small units, not suitable for work on sections with but little traffic; and if steam automotor cars are in question, it is not evident why arrangements cannot be made, not only with automotor cars but also with light locomotives, to satisfy all requirements (1).

Taking it altogether, the utilization of automotor cars, in order to be definitely economic, necessitates, in the first place, the conveyance of a regular passenger traffic by means of such cars; secondly, it must not be necessary to have types of large capacity and high power, in which the advantages of the combined type of vehicle are more or less lost. If therefore, this utilization is to take place on one section only, the traffic must be inconsiderable and but little variable. If it is possible to run a certain number of automotor cars, for the purposes of a regular service, on a group of minor railways which are close together, the difficulties and expenses which result from a specialized stock then become less, for it is then possible, without undue increase of reserve, to have several units in addition to those running regularly, so as to be prepared if any of the latter are laid up, or if a sudden increase in the traffic makes it desirable to run extra trains; nevertheless it is necessary that on the sections considered, there should be not much passenger traffic and that that should be fairly regular at all times, so as to make it possible to use small units without increasing the number of daily runs, for the latter would not be compatible with economic operation (2). Now it must be recognized that these conditions but rarely obtain in the case of secondary lines owned by the administrations of main railways.

These administrations have most certainly taken all these conditions into consideration. Not one of them has neglected the question, and it could hardly have been otherwise, considering all the inducements offered. For not only was there the possibility of improving, without excessive cost, the passenger service on their minor lines, at a time when competition by motor cars on the highways was to be feared; but there were also the expected advantages (increase in the number of trains, the use of new stock instead of the old generally placed on the section with little traffic) which the public was continually crying for (3). The higher authorities, in the presence of such an evident progress, insisted at the same time that this progress should be utilized, and it is hardly necessary to add that builders promoted this

(1) We have even recorded the fact that the Hungarian State Railway owns some light locomotives which are driven by one man only, while on the other hand there are two men for driving the motor of automotor cars.

(2) This increase moreover quickly increases the cost of the train staff, however few this may amount to per train-unit.

(3) On certain automotor cars there were disagreable vibrations which did away with some of the comfort which was expected from the new vehicles, but this detail remained rather unnoticed; moreover an instinct of simple curiosity increased the public favour for automotor cars.

general advance of opinion, by producing remarkable and seductive patterns of cars.

It is not surprising that when such a current of opinion set in, all in one direction, the mark was occasionally overshot. Nevertheless, in many cases, it was decided to reject the system, without even making trials ; in other cases, one has gone beyond this, it would seem, and accepted certain results only with the object of going as much ahead with the matter as possible. As regards the managements of great railway systems, but few in number, who have instituted regular automotor car services on the sections where there is little traffic, it is to be noted that the first experiments have occasionally resulted in the utilization of automotor cars outside those sections, the majority recognize, in their answers, the more or less definite want of success of these attempts, and it appears indisputable that they will be all the less inclined to extend or generalize this system in the future, as the lines experimented with at the start, were evidently those where conditions were most favourable.

On the other hand, it would no doubt be desirable to examine the few answers which record that successful results have been obtained with automotor cars, in order to ascertain what the determinating factors of these results have been, and in order to obtain at least an approximate estimate of the financial results attained. These answers are however unfortunately not explicit on these points, and are limited to simple affirmations, so that it is not possible to proceed even to a summary analysis. But out of all the conclusions which we are able to draw from our investigations, there is to be remembered this fact of capital importance, that in spite of the ardent desire of the administrations of main railways to organize automotor services, the latter have in the end only been instituted on very few secondary lines, and that most of these attempts have by no means given very satisfactory results.

In truth the objection might be raised that as a large number of the main systems has during the last few years had to expend considerable sums on acquiring rolling stock for their main lines, they thought it inadvisable to order at the same time automotor stock for their local lines, the more so as their purchases resulted in leaving a quantity of the older rolling stock available for the purpose. But we do not think that this reason would have sufficed to restrain the administrations from at least making trials, if they could have expected, after the trials, those extensive economies which it was at first hoped would be realized by the use of automotors.

Finally, it may also be argued that better chances of success would result if the number of automotor services were increased, so that a greater number of interchangeable units would become available. But in spite of all this, the difficulties described would not disappear completely, and those which experiment has revealed are in themselves sufficiently serious to prevent, in our opinion, any larger extension of such services on the lines we are considering.

If in order to render our investigations more concrete, we limit them to the great French railway systems, we find that two of them, the Eastern and the Western (now forming part of the State system) have given up all trials of automotor cars,

although in the latter case, more especially, the number and condition of the lines with little traffic had been the subject of most careful attention, and every attempt had been continually made to apply all possible means of economical operation. The State and the Midi railways, after some experiments, not on secondary lines however, gave up the idea of automotor operation. The Northern Railway has made experiments of different kinds and is continuing them without having as yet arrived at any definite system; it is trying to adapt such a service to its suburban sections rather than to minor lines. Finally, there are only the Orleans and the Paris-Lyons-Mediterranean who after the first trials made with single units, determined to run regular automotor services on some of their lines with little traffic; although, strictly speaking, these are at present only really trials, but on a more extended scale than at first. They certainly have not succeeded in realizing, by the methods adopted, any indisputable advantage, and they do not express the intention of generalizing, or even of extending this system, which taking it altogether seems to be of very limited application, at all events as far as France is concerned.

It is also necessary to record, at the present time, a certain reaction; and several railway administrations show a tendency to adopt, for minor railways, rolling stock of the ordinary type, rather than automotor cars.

Thus we have seen that the Bavarian State Railway, while running some automotos cars on their main line, have tried to operate the lines of local interest by means of light trains, hauled by locomotives designed to be run by one man only. This administration has also just instituted, on a main line (Munich-Nuremberg), but for local traffic only, a new organization of trains with special rolling stock, and is has decided on locomotives and carriages designed for this special purpose.

We have also quoted the opinion of the French State Railway, which seems to prefer, in such cases, light locomotives to automotor cars.

It is, moreover, rather a rare thing for administrations of important railways to have to consider questions of this kind, for as a rule they use up their old stock on the secondary lines; and cases where conditions were otherwise have no doubt been exceptional during the last few years; more especially, as regards secondary railways, as what was more particularly attempted was a transformation of the passenger services by using automotor cars only.

The problem thus arises more frequently in the case of secondary systems, when new lines are opened to traffic. As the latter are outside the scope of our report, we have not subjected them to investigation, although the factors concerned are very similar when it is a question of using specialized stock for the service on a given line, no matter what railway system it may belong to.

We may however state that the tendency mentioned exists in these cases also, and that we know of several recent cases where secondary systems which had to acquire new rolling stock decided on light locomotives and carriages of the current type.

We must in fact recognize that the existing situation is very much the sams as it was before the recent experiments on the use of automotor cars on secondary rail-

ways. Are there now perhaps more cases in which automotor cars are superior, owing to the improvements made, when similar experiments have been made in the construction of light locomotives? It would be difficult to assert this, but in any case it is no longer possible to look on the use of automotor cars, for operating the service on lines with little traffic belonging to main railways, as a general solution, capable of revolutionizing the economic operation of such lines.

We may however remark that such a transformation, or at least a great extension of the limits inside which the use of automotor cars is advantageous, may result later on, on the other hand, if such lines are electrified; for it is readily seen that the objections against petrol or steam automotor cars disappear or are much reduced in the case of electric cars, where the motors occupy but little room while if necessary, being of great power; and such cars are easily driven by one single man, even if several units are joined together, as may be required. And this makes it also possible, on the other hand, not to multiply the individual runs per day on days on which there is a rush of traffic.

SUMMARY AND CONCLUSIONS.

At the 1905 Session of the Congress, the discussion on the simplified methods of operating lines with little traffic (then all these lines were included, whether belonging to a main railway or not) became concentrated exclusively on the conditions under which automotor cars could be used, and it cannot be doubted that it is that part of the question which alone led to the demand for an ultimate continuation of that discussion. Since then, as was to be foreseen, very few innovations have appeared, as regards such methods as a whole.

In most of the countries, the laws and regulations affecting secondary railways have not been altered; in some of them however, particularly in Germany and in Austria and Hungary, the working regulations of these railways have been improved, most frequently as regards their details.

Generally speaking, the administrations which have expressed any opinion on the subject, consider that the legislative provisions in force are sufficiently liberal. The railways of the United States of America, on the other hand, declare that the laws under which they work, while not establishing any distinction betweeen main lines and secondary lines, do not enable them to adopt on the latter lines any of the economic methods ordinarily used elsewhere.

The regulations issued since 1905 on the conditions and hours of work of the employees do not seem to have resulted in any alterations in the working methods which already existed.

As regards measures taken by the administrations themselves, recent regulations

have in Germany and in Austria and Hungary made possible some improvements and simplifications in the service on local railways. In other countries, one has nearly always been contented to continue existing methods, merely extending or limiting them in accordance with the variations in the importance of the traffic on certain sections.

We may however note, as having given rise to important applications :

The use of the telephone, which tends to replace the telegraph more and more, even for the transmission of orders referring to train movements;

The complete closing of small stations, during certain hours of the day;

The reduction, to a minimum of two men, of the number of employees on minor trains, measures being taken to enable one man to drive the engine.

It may be added that in spite of the attempts made to reduce the unit cost of small trains (light locomotives and carriages, automotor cars), the system of mixed trains is still recognized, in principle, as the most economic for the operation of local railways; in addition it makes it possible to accelerate the circulation of the goods stock.

As regards automotor cars, it is more particularly in this direction that the greatest efforts have been made to improve methods of operation on secondary lines. In spite of the investigations made and of the improvements introduced in the construction of such cars, only a few administrations of main railways have finally adopted a normal organization, at some points, of automotor cars or have even proceeded to make trials simply. Practice has shown that these cars give rise to rather serious difficulties in working, either by being frequently laid up for maintenance or repairs, or, and still more so, by their want of capacity when there is a rush of traffic.

When it is not possible to use such small units (and this is often the case on lines with little traffic), the advantages characterizing the combination vehicles are much reduced, and finally, sundry railway administrations tend today to prefer light locomotives, when they consider it advisable to form, on the sections in question, the passenger trains of special rolling stock.

In any case it appears certain that the use of automotor cars will not become extended, as a method of economic operation, on the many lines with little traffic belonging to the main railways, and that from this point of view such use will be limited to some of these lines only, where there is but little traffic, and where the amount of traffic varies but little during the year.

Taking all the preceding information into consideration, the sole conclusion which is for the moment apparent refers to this use of automotor cars. As regards the rest, as the state of affairs is very much the same as in 1905, we think it suffices to place this on record. We therefore propose the following conclusions :

Since the last session of the Congress, very few alterations have been made both in

the legislative provisions and in the methods of economic operation of lines belonging to main railways but carrying little traffic.

The attention of the railway administrations had been drawn specially to the use of automotor cars, and it was in this direction, in fact, that nearly all the researches for improving the service on these lines tended.

According to the experience which has now been obtained, this solution will not lead to a general transformation of this service, and it would seem that it can only be ranked among economic methods applicable to particular cases, when there is a combination of favourable conditions.

APPENDIX.

Detailed list of questions relating to question XVII.

I. — Legislative provisions.

1. Have there been enacted in your country since 1904 (the date when information of the same kind as that sought in the present list of questions was supplied for the last Congress), any laws or regulations regarding the simplification, on lines carrying little traffic but belonging to main lines, of the general rules regulating the operation of railways? If so, kindly communicate these provisions, drawing attention to how they differ from the previous legislative enactments.

2. Have any other laws or regulations — relating for instance to the conditions and hours of labour — had any appreciable effect on the previous methods of operating your lines with little traffic cheaply? If so, mention the alterations necessitated by these laws or regulations.

3. Are there any laws or regulations at present being drafted with a view to simplifying the operation of lines carrying little traffic belonging to main lines? If so, in what direction do the simplifications under consideration tend?

4. What improvement in the present legislative provisions seem to you advisable to increase the facilities and save expense in operating your lines with little traffic?

5. By what characteristic does the legislation in force recognize the secondary lines of your system? Does its character follow from a classification adopted beforehand; does it depend upon the number of the trains, their composition, their speed, the intervals between two consecutive trains in the same direction, a shuttle service, maximum mileage receipts, etc.?

II. — Actual methods followed in working lines with little traffic cheaply.

6. What modifications have been actually instituted since 1904, in working your lines with little traffic cheaply? Have you extended or curtailed your previous methods of cheap working? Have you introduced them on new lines? Have you, on the other hand, abolished them on lines where they were previously in existence?

7. Have you introduced on any of your lines with little traffic any new methods of cheap operation, affecting either operation properly so called, or the simplification of appliances (track, stations, signals, etc.)? In what do they consist?

8. Have you succeeded, in any instances, by separating your passenger service from that of slow goods, in reducing your operating expenses? Did not this organisation tend more towards an attempt to develop the traffic or was it really cheap in itself? Kindly explain the individual circumstances that made it possible to effect a saving.

9. Does not operation by mixed trains, utilizing the various trains in the day for working off goods wagons, result in-or is it not likely to result in-liberating the goods stock more rapidly?
If you have tried to derive this advantage, by using mixed trains, of a more rapid circulation of your goods wagons, what measures have you adopted to this end?

10. In a general way, have your methods of working lines with little traffic cheaply tended towards the more rapid circulation of the rolling stock? If so, state what advantages or losses result therefrom.

11. In the service of your lines with little traffic, do you make use of trains with a reduced complement of staff or vehicles? What are the accepted regulations on this point? Does such reduction extend to mixed trains? Is it current practice on your lines with light traffic; does it frequently happen or only in a few special cases?

12. When utilizing engine and car of the ordinary pattern (with or without minor alterations), have you succeeded in employing one man only on the engine? Under what circumstances has this practice been found feasible? What minor alterations especially have had to be introduced with this object upon the engine or car of the ordinary pattern?

13. If a train has accidentally to pull up between stations on a line with little traffic, have you simplified your ordinary regulations for its protection? If so, what special measures have been adopted in such a case, especially when the train staff has been reduced in number?

14. Do you use automotors on any of your lines with little traffic? Does this apply to isolated lines, *i. e.* operated separately by a small number of automotors, or to a group of lines connected to one another from the standpoint of their service by automotors and requiring altogether a fairly large stock of motor units?

15. What patterns of automotors are used? Seating accommodation for passengers of different classes, room for luggage or quick freight, mails, etc.?
Kindly furnish a rough plan to show the arrangement of these automotors.

16. Are the automotors used by themselves or with one or more trailers, normally or exceptionally? What is the maximum composition of a motor train (vehicles, seating accommodation, quantity of goods, etc.)?

17. In using automotors, how do you contrive, if need be, to convey certain quick freight traffic in definite separate wagons (coffins, live-stock, etc.)? Do not difficulties arise if such traffic offers itself?

18. What are the average (partial or complete) daily runs of the automotors in the various cases in which you use them? How long are the minimum compulsory stops between two consecutive journeys?

19. At places where you use automotors to serve lines with little traffic, what number do you find requisite for the normal service? How many do you keep in reserve, above and beyond this number?

20. How do you cope with extra traffic, either when expected and periodic (fairs, market days, festivals), or when unexpected or exceptional.

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21. Are you not obliged more or lass frequently to substitute trains of the ordinary kind for automotors? Does not this result in inconveniences and expenditure which appreciably detract from the advantages arising from the use of automotors?

22. What is the average annual number of days that the automotors actually run and the number of days they are laid up for maintenance, repairs, substitution of an ordinary train for the automotor etc.? Are not these automotors more often laid up for maintenance or repairs than the ordinary rolling stock?

23. Taking into consideration the objections to the employment of special rolling stock, lying idle, substitution of ordinary rolling stock, etc., does the use of automotors appear to you on the whole economical in itself on lines with little traffic?

III. — Results obtained.

24. Selecting as instances any of your lines with little traffic upon which you have introduced cheap working and which appear to you of sufficient interest to mention, please say what results have been attained, giving figures in support of your statement as far as possible, and explain any peculiarities in plant, traffic or operation as regards these lines.

Please mention more especially, with a view to advantageous comparison :

a) the general features of the construction of the lines under consideration (length, gradients, curves, number of stations, halts or other stopping places, equipment of the various stopping places, passing places, gates and barriers at level crossings, signals, telegraph and telephone installations, alarm bells, etc.)

b) the general features of the traffic (quantity, in each direction, of passenger traffic and of slow and fast goods traffic, subdivided by sections if requisite — peculiarities of the traffic : variation, kinds of the bulk of the traffic, etc. — and distinguish if need be between the local and through traffic.)

c) simplifications adopted in operation, control of the service, specialisation of staff, general expenses, general service of stations and trains, employment of women or outsiders, leasing, daily number of trains in each direction, kind and composition of these trains, utilisation of special rolling stock, manner of issuing tickets, forwarding and receiving luggage and slow or fast goods, accounting, handling of money, maintenance and inspection of lines and buildings, etc.).

d) number of employees per kilometre of line, subdivided into classes.

e) extreme hours of service per day — trains and stations.

f) the amount and approximate value of the motive power and rolling stock, both of what is in regular use and in reserve, employed for the service of the line and set apart for this purpose (including only a portion of the value of these appliances if they are used simultaneously at other points).

g) as regards non-specialised rolling stock (*i. e.* doubtless all the slow goods stock, considering what lines are under consideration) the number of wagons coming each day upon the line, in times of ordinary traffic and at the time of the maximum amount of traffic, and the average period

during which these wagons remain on the line in each of the above seasons, the period being counted from the moment when a wagon reaches the junction station until it gets back to this station.

(Give separately, if need be, statements as regards local traffic and traffic in transit).

Indicate the value and load of the wagons usually employed in the service of the line.

h) the financial results :

Annual receipts, subdivided according to their nature : passengers, luggage and dogs, express goods, slow goods, extra receipts (subdivided also, if need be, into warehouse receipts and through conveyance receipts).

Annual expenses, subdivided, as far as possible, according to the various departments : management and general expenses, permanent way and buildings expenses, locomotive power and running expenses, station expenses and agency charges, etc.

(In expenditure on rolling stock, it will be necessary to exclude such as belong to the maintenance of rolling stock not specially kept for the service of the line.

SECTIONAL DISCUSSION

(3rd and 5th SECTIONS MEETING JOINTLY.)

Meeting held on 8 July 1910 (morning).

MR. DIETLER, PRESIDENT OF THE 3rd SECTION, IN THE CHAIR.

The President. (In French.) — The President of the 5th section having asked me to take the chair at this meeting, I call upon the reporter to give us a summary of his report.

Mr. Quarré, *reporter*. (In French.) — Gentlemen, before giving a summary of my report on question XVII, I wish to pay tribute to the memory of Joseph Rocca, reporter on the same question to the last session of the Congress, who was one of the victims of the earthquake which devastated Messina and Reggio in Calabria, on 28 December 1908. I was unable to do this when I drew up my report, as I was then ignorant of his tragic end which I only knew later.

In the August 1909 number of the *Bulletin of the Railway Congress* an obituary notice paid a just tribute of honour and regret to the memory of Rocca, in which I humbly wish to join.

I only had but too few opportunities, during journeys of inquiry in Italy, to meet Mr. Rocca, but they were enough to show me not only the extent of his professional knowledge but also his extreme affability and complaisance.

The members of the 3rd and 5th sections, especially those who knew the late Mr. Rocca, will understand why I have occupied a moment of their time in order to pay this posthumous homage to him. (*Approval.*)

The President. (In French.) — We all wish to join in the touching remarks which the reporter has just devoted to the memory of the late Mr. Rocca. (*Hear ! Hear !*)

Mr. Quarré, *reporter*. (In French.) — Gentlemen, the resumption of a discussion concerning the means of organizing a cheap service on a main railroad's branch lines which carry little traffic does not seem, under present conditions, to be of much interest, at least as far as most of those means are concerned.

At the last session of the Congress, that

is only five years ago, it already seemed that there was but little to discuss. In spite of two very full reports to the Congress, the discussion becomes at once limited *exclusively* to an exchange of views concerning the possibility of running automotor cars on more or less steep gradients.

There is no doubt that general attention was then drawn to the problem of the use of automotor cars on branch lines. That was what gave the question a revived interest and led to its retention in the agenda of the present session.

Thus this question, long considered, examined from every point of view, solved today as regards its main features, can only be reconsidered in two ways : either by a careful study of improvements made in details, or by a more general examination of the first results of some new system, of a kind to modify the conditions of the problem. Now a detailed analysis would only have been possible if the work had been divided among a number of different reporters, instead of having only one reporter for all countries. It is hence probable that the chief object in view was that part of the question concerning automotor cars whose utilization (apart from some few experiments made at earlier dates) was considered a new development, capable of modifying the operation of the traffic on branch lines.

Be that as it may, and given the state of the question, taking into consideration the reports presented in 1905, I thought it would suffice if I brought the reports presented to the last Congress up to date, and it was with this object in view that my inquiries were addressed to the managements of the main railroads.

As these inquiries were very extensive, I had not time to supplement them by making other investigations, direct, in the different countries, and my report is based nearly wholly on the information received in answer to my list of questions, incomplete though it may be.

The report naturally includes two chief divisions, namely legislation and methods of applying it, that is to say, firstly, the orders coming from the supreme authorities, which the railway administrations have to obey, and secondly the rules made by those administrations themselves.

We will begin by examining legislation.

The laws and regulations concerning the branch lines of main railroads have been modified, since 1905, only in very few countries, and in those the modifications have been but slight. I have only to mention the following :

In Germany and in Austria, the regulations affecting the operation of secondary lines have been modified, especially in Germany, with a view to the better coordination of the existing prescriptions, avoiding ambiguities. In both countries, the modifications which are of any importance do not affect fundamental principles, but only working details, allowing methods already known and used to be extended. In Italy, where a complete reform of the act of 20 March 1865, concerning railways, was expected, there were only some few modifications in the act of 9 June 1901, concerning the lines described as with " economic service ".

Finally, in England, as regards automotor services, the prescriptions referring to the construction of the track and of the buildings at stopping places between two stations have been made less strict.

On the other hand, the main railroad administrations who have expressed any opinion about the subject, have stated that they are generally satisfied with the laws and regulations applying to lines with little traffic.

Several administrations in the United States, however, think that the laws in force which make no distinction between main lines and secondary lines, do not give those facilities which are usually granted elsewhere.

Incidentally, I had asked whether other legislative enactments, for instance those affecting the conditions and hours of work, had not involved changes in the organization of the services. This does not seem to have been the case, in spite of the resulting increase in the cost of labour, which is considerable in some cases.

Thus from this first point of view, the opinion of a rather large number of railway administrations is that the legislation affecting secondary lines is today sufficiently liberal not to hamper the service unnecessarily. The experience acquired in this way makes it quite possible to draw up laws and regulations suited to lines with little traffic, and if some legislation is still too strict, this is certainly due to causes which are wholly of a non-technical order.

As regards the methods of applying the existing legislation, the answers show that the administrations of the main railroads have only made few and unimportant changes in their methods of operating secondary lines.

That was to be expected, the legislation having so to say hardly changed, and the authorized facilities being already in existence on the sections where it was considered advisable to apply them. Moreover, several administrations stated that their chief attention had been devoted, during the last few years, to their main lines. Finally, it cannot be denied that, as regards secondary lines, recent investigations nearly entirely had in view the use of automotors.

The following points are alone worth noticing :

The extension of the use of the telephone instead of the telegraph.

The complete closing of small stations at certain hours of the day so as to enable the proper observance of the regulations concerning the hours of labour, without employing any extra staff.

The continuation of the experiments made with a view to reducing the number of employees on small trains to two, the locomotive being driven by the driver alone.

These very interesting experiments have been made, either using special devices, as for instance the automatic firing of the engines or using the ordinary devices but arranging matters in every case so that the second employee can go on to the locomotive and help the driver if necessary. This system of having only the driver on the locomotive is as yet but little developed and many administrations hesitate to try it. It seems that this is a point about which valuable investigations can still be made.

Finally, on some railways, on the sections where there is little traffic, the system of keeping separate the goods trains and the passenger trains has been extended, less with a view to economize operation proper than with one to give the public a better service, without any corresponding

direct gain. The railway administrations recognize generally that in spite of the new methods adopted for reducing the cost of small trains per unit train, the system of mixed trains is as yet the most economic.

As regards the simplified methods of working, taking them altogether, it may be asserted that they are perfectly well known and sanctioned by sufficiently long use. Investigations having been carried out in all directions, these methods are sufficiently numerous and variegated that given suitable laws, one can always find one capable of satisfying the needs of the traffic at a minimum cost. It is beyond doubt that if the administration of a great railroad does not adopt such and such a method which is authorized by the regulations, this is not for want of consideration, but because it has not seemed to it to satisfy the requirements of the particular case in question.

Before passing to the consideration of automotors, I may remark that another division of my report might consider separately lines worked economically; but this division which followed that adopted in 1905 by Mr. Rocca, was only due to the special position, in Italy, of the lines with "economic service", as the legislation there only authorizes these working facilities if the number of trains is increased and the rates are lowered. Accordingly, this belonged rather to that part entitled "*Legislation*", in my report. But everywhere else it was a question, in the case of the lines worked economically, of the simplified system of working which consists of grouping together several secondary sections, giving them a special administrative organization, forming them, so to say, into one small railway system. That is in fact a method only applied among sundry other methods for the economical operation of lines with little traffic.

Moreover, the position of the "economic service" lines in Italy has remained very much the same since 1905, and as regards economically-operated lines in other countries, there are also very few recent applications of this method.

The examination of the utilization of automotors still remains. This examination is limited to lines belonging to main railways but carrying little traffic, leaving out of consideration, moreover, the technical questions relating to construction and operation included in question XII of the present Congress.

Some years ago, it was expected that there would be a great extension in the use of these vehicles on secondary lines. It was even expected that there would be an entire transformation in the service, due either to a great increase in the number of trains run per day, or to the complete separation, without incurring too great expense, of passenger trains and goods trains.

Mr. Rocca concluded his report as follows :

> We think that the true solution of the organization of a cheap service on lines which carry little traffic will be found in the proper use of suitable automotor cars.

In 1905, we were still in the experimental period. The units which were running served above all as experiments in order to determine the cost of working and the technical value of the design of the different types of cars. Considering the improvements since made by the de-

signers, that part of the problem may now be considered sufficiently solved.

During the last few years, such investigations have been made by all the administrations of great railroads. There is certainly not one which has not considered how to organize automotor-train services on sections with little traffic. Nevertheless most of these administrations have decided against them. Out of forty-three answers received about this point, thirty state that no automotor car is actually in use on their secondary lines. My report also contains other answers from administrations having automotors on some of their lines; it shows that generally speaking those automotor services are few in number and not much developed. Most of them, strictly speaking, are but experiments which are being continued, while the results are not yet sufficiently definite to make it advisable to extend this method of operating the traffic.

The only administrations which definitely state, without any special reservation, that they are satisfied with the adoption of a normal service of automotor cars are the following :

1° In Germany, the Wurtemberg railways.

However the automotor trains are nearly only *on main lines*. In the case of some branches, they can hardly be considered as more than continuations of main lines, when the continuation can easily be covered by the automotor train in its daily run.

We may note that of seven German railway managements which sent answers, six have no automotors on their lines.

2° In the United States, the Union Pacific Railroad.

It would have been very interesting to know the traffic conditions on the lines of that railroad, on which automotors are used, as well as the special conditions which made possible the excellent results obtained; the more so as of ten administrations in the United States which sent answers, the Union Pacific is the only one which has adopted this system. I have not been able to obtain any detailed information. The cars are of comparatively high power and run at high speeds; such do not *a priori* seem to be the usual conditions in the case of a local-line service.

3° In the United Kingdom, the Lancashire & Yorkshire Railway.

The use of automotor cars is however very limited, the company stating that the lines on which they run only have a total length of 22 miles.

I may add that out of six answers received from English companies, three only say that they use automotor cars. Two of the latter state, the first that the use of these cars does not seem to be very economical, and the second that the trials have been begun too recently to make it possible to form an opinion.

As against these few favourable answers, all the other administrations of great railroad systems which have automotors on their lines record the more or less marked failure of this system, or at least make reservations and do not feel inclined to extend it. The extension is all the less probable as the trials were no doubt begun on the sections most suitable for the experiment.

To begin with, nearly all the answers state that automotor cars require repair more frequently than the ordinary stock. This is not surprising, because, in the first place, we have in one lot both the engine

and the body of carriage; moreover, in designing such combination vehicles other troubles arise, especially from limiting as much as possible, the space the motor occupies. But according to those answers the most serious defect of automotor cars is their want of flexibility; they are unable to meet the day-by-day requirements of a varying traffic and hence it often becomes a necessity to substitute ordinary trains.

Mr. Rocca thought that once the automotor-car problem had been solved from the technical point of view, it would easily be solved from the commercial point of view. Now the experience of the last few years negatives this opinion. The branch lines of main railroads usually have such varying traffic that it is very difficult to deal with regularly by means of automotors.

These frequent replacements, which make it practically necessary always to have ordinary stock available, evidently much reduce the economic value of the new method.

Moreover, the great railroads nearly always have available, for use on their branch lines, stock withdrawn from use on their main lines, so that they do not need new stock for them. That is an important point which has to be considered when comparing the different methods of working. Moreover, any specialization of stock always involves a certain amount of trouble and expense, and this specialization is especially marked in the case of automotor cars, as it extends both to the engines and to the rolling stock.

However that may be, when the question has to be considered of buying new stock for use on a local line, there is at present a tendency in favour of light locomotives rather than automotor cars.

In any case, it certainly seems at present that the use of automotor cars, *on a main railroad's branch lines which carry little traffic*, is not profitable unless the traffic is very limited, and above all does not vary much during the course of the year. Now such conditions only exist in a small number of cases.

Finally, it is interesting to note that most of the previously-mentioned objections disappear or are much diminished if it is a question of electric automotor cars, and it may hence be hoped in the future, when the branch lines are electrified, to obtain with success those transformations in the service which appear difficult to realize under present conditions.

The remarks I have just made are based, as I have already explained, on the information which I received in answer to my list of questions, and on some other, but limited, information which I was able to obtain direct. This brings me to the following conclusions which I have the honour to submit to you:

Since the last session of the Congress, very few alterations have been made both in the legislative provisions and in the methods of economic operation of lines belonging to main railways but carrying little traffic.

The attention of the railway administrations had been drawn specially to the use of automotor cars, and it was in this direction, in fact, that nearly all the researches for improving the service on these lines tended.

According to the experience which has now been obtained, this solution will not lead to a general transformation of this service, and it would seem that it can only be ranked among economic methods applicable to particular cases, when there is a combination of favourable conditions. (*Hear! Hear!*)

The President. (In German.) — We will now proceed to the general discussion during which the different delegates can give us any information they have available, so that we may be able to consider the question from every point of view. After this general discussion, we will consider the conclusions given in Mr. Quarré's report.

Mr. Suarez had inscribed his name, but as he is not present, I call upon Mr. Campiglio to address the meeting.

Mr. Campiglio, Italian Union of local railways. (In French.) — Gentlemen, I think I can give you some information as regards the economic side of the question, about the trial of economic services made on the Italian railways

The trial was in the first place made on lines of the former Adriatic and Mediterranean systems. In accordance with certain special provisions of the law, the rates for conveyance were reduced and fixed stamp duty was changed into a *pro-rata* tax of 1·50 per cent.

The trial was made with reference to the changes required in the service with a view to making it easier: one class of passenger carriage was abolished, the classification of goods was simplified and there was a considerable reduction in passenger fares, a reduction amounting to about 45 per cent.

The favourable results obtained as regards passenger traffic, are to be attributed to the reduced fares and the increased number of trains. The number of passengers has doubled; in some cases it has even become sevenfold.

The trial was not, however, made general, on account of several reasons. In the first place, owing to the conditions of their contract with the government, the great railways had no interest in extending such services. In fact the addition of at least a couple of trains meant for them greater expenditure, not compensated by the gross receipts after the government tax had been deducted.

It is, however, true that in a general way, the economic service has been advantageous, especially to the public; but the latter has not always appreciated this. The new classification of goods gave rise to many complaints and the economic service was limited, after a certain time, to the passenger traffic.

As regards the reduction of passenger fares, this applied, practically speaking, only to the third class; hence it interested only people who previously had hardly considered the subject. Protests were made against the introduction of the economic service on certain lines where an ordinary service was operated.

It was thought that the economic service would lower the importance of the line.

As far as lines owned by private companies were concerned, the question assumed quite a different aspect.

An economic service could not be profitably introduced on them because the 5-centime ($^1/_2$ *d.*) stamp tax on each ticket would necessitate a great reduction in the rates, particularly in the case of short distance traffic.

The Apennine Central line had applied passenger rates similar to those in use on the great railways. But what happened? Although the number of passengers doubled, the receipts and expenses remained about the same and it was the government

which made a profit of about 14 per mil in consequence of increased receipts from stamps. Hence, the company did not benefit.

The conversion of the fixed tax into a *pro-rata* tax, desired by the private companies, met with much opposition from the government. It was only granted subject to a number of other conditions ; in particular the government shared in the increase in the receipts and in the increase in the number of trains of two classes.

The imposition of these conditions hampered and delayed the introduction of an economic service on privately-owned lines, for which concessions had been granted. As a consequence of this state of affairs, there are as yet no conclusive results worth mentioning.

I have just now received a telegram from Milan informing me that the chamber of deputies is considering the request that the fixed tax should be converted into a *pro-rata* tax.

It is accordingly to be hoped that the light railways will be able to make trials on a larger scale.

The President. (In German.) — Can Mr. de Burlet not give us some information about this subject?

Mr. de Burlet, Belgian National Suburban Railway. (In French.) — As you know, the Belgian National Suburban Railway Company only operates light railways and the trials it has up till now made with automotor cars, have not yet given any conclusive results.

A year ago, we started trying a benzo-electric car. The results seem rather favourable, but the trial has not yet been long enough to enable us to give you any definite information which might serve as guide.

Our company, in Belgium, is placed under very favourable conditions as regards the making of trials and we intend carrying them out on a larger scale. We have already ordered four cars of the same kind, which we shall put in service at the end of August on Brussels suburban lines, lines where there is a great deal of traffic, which are more of the nature of tramway lines. The motors will be powerful enough, we hope, to haul a second trailer or even a third, when there is a rush of traffic.

If among our colleagues here there are any who intend to visit the Brussels exhibition, it will be a great pleasure to me to show them those automotor cars in regular use.

Matters being as they are it is impossible, I again say, and in any case premature, to give now any definite information about the two essential points : the cost of fuel and the cost of maintenance. It will probably be possible to give this information at the next session, if the question is then on the agenda.

Mr. de Sousa, Portuguese State Railway. (In French.) — Gentlemen, I am going to give you some general information about the operation of lines with little traffic, included in our railway system, and also about the results obtained with automotor cars from the general point of view.

We operate, particularly in the south, lines in a country which is nearly wholly agricultural. The population is rather scattered and consequently we find a service of mixed trains to be the most satisfactory. They give us the greatest facili-

ties from the point of view of the goods traffic.

So far the operation of secondary lines has not yet all the flexibility desired. As a rule, the concessionaries are hampered by traditional and classical rules, which are satisfactory for main railroads, but which are rather troublesome to the concessionaries. Rather more facilities should be granted to them.

As regards automotor cars, the results obtained leave us undecided as to what opinion to form on this subject.

We have used cars with a steam motor on the Borsig system, with a motor bogie which could be detached from the car, so as to make it cheaper to repair the motor and make it possible to utilize the car better. These automotor cars can haul one or even two trailers if necessary. They serve more as an attraction to traffic. One is often troubled by the variations in the traffic. There is no sufficient opening. There is also the difficulty of running backwards, etc. It is difficult to obtain a satisfactory service under these conditions. There is also the question of the supervision of the track.

To sum up, automotor cars are only of limited use to us.

The President. (In German.) — It is satisfactory that several members wish to speak about this important subject. I now call upon Mr. Jaggard.

Mr. Jaggard, Pennsylvania Railroad. — I should like to ask a few questions with a view to getting a clear idea of the matter. It seems to me that European conditions are very different from American. First, as regards security : We, in the United States do not seem to have much option in the way of mitigating legislative requirements on railroads of feeble traffic. The federal authority called the Interstate Commerce commission, as well as the State commissions do not make much distinction as regards safety precautions, whether it be a large railroad, with important traffic, or a small railroad, with light traffic; thus the legislative demands are practically the same as regards automatic couplers, brakes, etc., for a small railroad a few miles in length as for the largest and most important lines. As regards signalling, the matter is not so fully developed, but the indications are of the same kind. For freight cars alone, there exist about six conditions that each vehicle must satisfy before it is a proper car to circulate on the railroads of the country. I should like to know how European authorities regard a mitigation of these conditions. Are you not afraid security may be affected thereby ?

Another question which I wish to ask relates to the facilities offered to the public. In America, almost every small farmer living on the line of a secondary railroad, demands first class service under all circumstances, however small may be the line, and how insignificant his traffic. If his wife wishes to go to a neighbouring town to make some trifling purchase she is anxious to have the same convenience, in the way of passenger train accommodation, as if she were traveling on a large railroad. If the farmer has hay to sell he demands the same attention for his small crop of hay as if he were one of the greatest shippers in the country. This picture is perhaps slightly exaggerated, but in the main is correct. This fact and the one already mentioned that there is no miti-

gation as to the requirement for safety are obviously a source of great difficulty for railroads. As I see it the situation is not the same in Europe, and I should like to know whether the people, who are badly served by these small railroads, are satisfied with the service less complete than on the other lines, both as regards safety and as regards facilities for shipping and traveling offered to the public.

Mr. René Jourdain, St. Quentin-Guise Railway, France. (In French.) — I think it useful to give some information, because during the last three years I have been comparing the results obtained with steam cars on a local line with those obtained with our old system of light trains hauled by small locomotives, on other lines. Now without wishing to prejudice automotor cars, oil cars for instance, which seem more like automobiles on rails, experience has proved this to me : the automotor car which we tried, in order to obey the dictates of fashion, which exists in the railway world as elsewhere, gave results which proved to us that this car had nearly all the disadvantages of the small locomotive or of the light train, without having any of its advantages. In the first place, owing to the very purposes the car is to be used for, the different details of the motor are placed close together and it is difficult to examine them; the dust of the road makes them wear and frequent renewal is necessary. In the case of small locomotives, even if light (10 to 12 tons), the parts are more accessible and upkeep is then much cheaper. Consequently, from the point of view of maintenance, the steam car is certainly inferior to the small locomotive.

From the point of view of the fuel, exactly the same is the case, for if one wishes to adopt, for instance, the system of feeding the grate continuously, all sorts of difficulties arise. It is necessary to use special and very expensive fuel, and thus the cost is increased without special advantage. It follows that the small locomotives weighing 10 to 12 tons, which can easily haul two or three passenger carriages together with a van to take goods, the latter being indispensable with us, make it possible not only to operate the passengers service with us, but also, what is also a necessity with us, to retain the mixed train; that little locomotive can do work which the automotor car is not equal to.

That is why, as far as we are concerned, we ask that automotor cars should be put away, and utilized only when one cannot do otherwise. It must be the general rule that they are replaced by small locomotives, which have given us every satisfaction for fifteen years. (*Applause.*)

The President. (In German.) — I now call upon Professor Ulbricht.

Mr. Ulbricht, Saxon State Railway. (In German.) — The point raised by Mr. Jaggard seems to me to deserve consideration and I will accordingly give some information about this point in the hope, however, that further information will be given by other members of the Congress. It is in fact a very important question to know whether secondary railways are to be treated, from the point of view of safety and of facilities, exactly like the ordinary lines of main railroads. I may say that in Germany secondary lines are required to give as many guarantees as

main lines. But the great difference is that the speed is less and that there are greater time intervals between trains. I think that taking these two points into consideration it is possible to graduate safety appliances, but the amount of safety to be attained must always be considered a constant. If the trains run at a lower speed and there are longer intervals between them, it is evidently possible to adopt simpler safety appliances, if only for reasons of an economic order. The great improvements made in safety appliances have only been of gradual growth. This has not been because their utility was not recognized sufficiently, but because the increase of speed, etc., made it necessary to strengthen the conditions of safety. As on secondary railways one is less advanced from this point of view, it is also possible to simplify the safety appliances. One can hence say : the safety measures necessary on a main railroad are not necessarily applicable to secondary lines.

The question of the facilities offered to the public is a particularly delicate one. It cannot be disputed that passengers wish to find on the secondary lines all the comforts they have become accustomed to on the main lines. Now it seems to me that one should absolutely oppose anything beyond what the real requirements of a smaller traffic justify. The comforts supplied by main lines for long journeys cannot be expected on small secondary lines. On the other hand, I do not think that one can refuse to give on those short journeys the comforts to be found for instance on good tramways. At the same time, one can have the advantage of simplifying the classes, that is to say, to adopt as soon as possible the principle of one class only, but suitably and nicely arranged. In this way, the economic needs of such a secondary line can be met rationally. I should like to hear, as I have already stated, what the members of this meeting think about this point.

Mr. Machowetz, Austrian State Railway. (In German.) — Automotor cars have been in use since 1904 on the lines of the Austrian State Railway, namely one Daimler petrol car, one Serpollet steam car and four Komarek steam cars. In the earlier years, very unfavourable results were obtained with those automotor cars as the design of the motors left much to be desired. The cars were more frequently at the repair shops than on the line, and the consequent temporary use of locomotives involved a large expense. Some time ago, the Komarek cars were much improved, and such are now in use. But we cannot yet give any definitive opinion whether it is more profitable to use light locomotives than automotor cars. In any case, the conclusion seems probable that the use of automotor cars on the State Railway will not become extended.

The President. (In German.) — Light lines have developed to an exceptional extent in Wurtemberg, Bavaria and Prussia. Perhaps a delegate from those countries can kindly give us some information about this subject which is of great economic interest.

Colonel Suarez, who inscribed his name at the beginning of the discussion, is not present. Is there any other member who wishes to speak in the general discussion?

Mr. Kareischa, ministry of ways of communication, Russia. (In French.) —

I should like to say a few words in answer to Mr. Jaggard.

In Russia, there are technical working regulations which all lines must observe. In the case of local lines however the minister of ways of communication has the right to modify these rules in a liberal direction.

The principle is the same as in Germany.

Mr. Maresch, Rumanian State Railway. (In French.) — The safety measures must be proportioned to the speed.

Mr. Quarré, *reporter*. (In French.) — There is another interesting question to be examined, that of reducing the staff on the train, the driver being alone on the locomotive. Can nobody give any information about this point?

Mr. Ulbricht. (In German.) — I can give some information about what we are doing in Saxony. The question of having a driver only on the locomotives on the secondary lines is still under investigation. The system has been adopted experimentally and as yet no appreciable disadvantage has become apparent; the conductor of the train is expected to help the driver on the way when he has not to attend to his own proper duties. Thus there are two men on the locomotive while running, but when starting and at the moment the train arrives at a station, there is only one. I am speaking for the moment of small steam locomotives. If electric traction is adopted, whether the ordinary trolly system or the accumulator system, it is possible to arrange matters — as I know has been done in Prussia — so as to make it easier to have only one driver on the automotor car; the current only passes as long as the driver holds the handle of the controller, so that in case of any moral or physical collapse of the driver the car stops. But I think that this organization can at present only be considered an experimental one and it is not yet possible to give a definite decision about this question of single driving.

Mr. Waechter, of the « Vering & Waechter » Company, Germany. (In German.) — In the grand-duchy of Baden, having one driver alone is authorized on lines with little traffic if the line is wholly laid, or at least nearly so, on an independent road-bed and if the cab of the driver is accessible to the other man on the train. The latter must know enough about driving the engine to enable him to stop the train.

Mr. Machowetz. (In German.) — In Austria, on the Prague-Cercan-Dobrzisch line, an automotor car is running on which there is one driver alone, but the conductor must understand the working of the motor sufficiently well to be able to help him. As a rule, we prefer to have a crew of two men because the attention of the motor-man is so much occupied in watching the track that he cannot drive unless helped by a second man.

Mr. Serani, Italian State Railway. (In Italian.) — The problem of the staff on the engine is solved in Italy on certain lines which are operated electrically (lines with much traffic). I may mention the Milan-Varese line and the Valteline lines. There there are electric locomotives driven by a single driver, the motor-man, assisted however by the train conductor who must know how to stop the locomotive or auto-

motor car and who is authorized to do so in case of necessity, for instance if the driver becomes ill.

The President. (In German.) — Does the reporter wish to add anything?

Mr. Quarré. (In French.) — No, sir.

The President. (In French.) — If nobody else wishes to speak, I declare the general discussion closed.

We now proceed to discuss the conclusions. There are three clauses.

The first clause is :

" Since the last session of the Congress, very few alterations have been made both in the legislative provisions and in the methods of economic operation of lines belonging to main railways but carrying little traffic. "

— Adopted.

The President. (In French.) — The second clause runs as follows :

" The attention of the railway administrations had been drawn specially to the use of automotor cars, and it was in this direction, in fact, that nearly all the researches for improving the service on these lines tended."

Mr. René Jourdain. (In French.) — It seems to me that the end of this clause is rather exaggerated; researches for improvements have evidently been made in many other directions. It would be better to say : " ... that a great part of the researches for improving..."

Mr. Quarré. (In French.) — I only speak of what has been done during the last five years. Now according to the information I have received, there have been very few changes during that time. It follows on the first clause which runs : " Since the last session of the Congress, etc.". Nearly all researches for improving the service, as regards the lines which we are considering here, have been in the direction of the utilization of automotor cars.

The President. (In French.) — The first part of the clause is not disputed : " The attention of the railway administrations had been drawn specially to the use of automotor cars."

The reporter then continues as follows : " and it was in this direction, in fact, that many of the researches tended, etc. "

I do not know whether the reporter can assert this so absolutely. Mr. Jourdain asks us to say " ... a great part of the researches..."

Mr. Quarré. (In French.) — We might say : " It is in this direction that since that date (namely the date of the last session of the Congress) nearly all the researches, etc. "

Mr. René Jourdain. (In French.) — It would be enough to say " ... a great part of the researches..."

Mr. Quarré. (In French.) — I do not quite see what else has been done during the last five years to modify the methods of economic operation belonging to main railways but having not much traffic.

The President. (In French.) — Does Mr. Jourdain uphold his proposal?

Mr. René Jourdain. (In French.) — The reporter mentions in his report the substitution of the telephone for the telegraph, which is an important modification; also the complete closing of small stations at

certain hours of the day, a practice which now exists on almost all the French lines of local interest; also the reduction in the train staff, etc. It accordingly seems that the very report itself contradicts the words " ... nearly all the researches..." in those parts in which the reporter mentions other interesting modifications.

Be that as it may, seeing the explanations of the reporter who declares that these words only apply to one particular question, I do not press the point.

Mr. Quarré. (In French.) — I do not oppose that we should say " ... it was in this direction that most of the researches..." instead of " ... nearly all the researches..."

I must however remark that it follows from all the answers I received, that the researches nearly all concerned the use of motor cars. Very few administrations have considered the other measures (use of telephones, closing of stations, etc.) which I have mentioned in my report.

Mr. René Jourdain. (In French.) — The use of the telephone, the closing of stations, etc., have been adopted generally or nearly all minor lines and the application of these measures has resulted in considerable simplification.

Mr. Quarré. (In French.) — Do you refer to the lines belonging to main railways but having not much traffic?

Mr. René Jourdain. (In French.) — No.

Mr. Quarré. (In French.) — Those are, however, the only lines which we have to consider.

Mr. Leverve, Orleans Railway. (In French.) — There is yet another improvement which should be mentioned, an important improvement which one has tried and still is trying to introduce from the point of view of the traction on small lines. I mean the use of small locomotives with a one-man crew. Several administrations have not been much satisfied with the results obtained with automotor cars and have tried to solve the problem by using small locomotives. They hope in this way to effect the saving obtained in the case of automotor cars; they even are thinking of transforming their old locomotives.

It would therefore be advisable to add that the trials made with automotor cars have not given any very conclusive results, taking them as a whole; and that the researches are being continued in the direction of the use of small locomotives.

It would in fact be a mistake to assert that all the researches were with a view to the use of automotor cars.

Be that as it may, researches were made in both directions and it is possible to think that the solution of the problem will be found in the use of small locomotives rather than in that of automotor cars.

The conclusion, worded as it is, conveys that the automotor cars have given no result and that nothing is to be done in this direction. That is not my opinion.

Mr. Dounine, Vladicaucasus Railway, Russia. (In French.) — During the last few years much interest has been taken in Russia in light railways. Nearly all the researches have been in the direction indicated by Mr. Jourdain. The station service has been simplified so as to save a large number of employees.

Mr. Jaggard. — I agree with the dele-

gates, who find' inexact the term " almost all "; it does not apply to American conditions where numerous attempts have been made in other directions to realize more economical methods of railroad operation. We have made many trials with the telephone for train dispatching and have much confidence in this system; moreover, we have made a great many trials with a view to obtaining and adopting more substantial rails, also different systems of signalling, with a view to obtaining uniformity and simplicity.

Finally, we have experimented with cross-ties of different kinds, among others, ties treated with creosote, by different processus, in order to prolong the life of the tie. The Union Pacific Railroad in particular has made a great many trials with electric motors, but as a rule, upon most of the railroads the object of economy has been pursued by trials in other directions. I have just mentioned some of these.

The President. (In French.) — Mr. Jaggard thinks that the second clause of the conclusions should be struck out and Mr. Leverve proposes that it should not be stated in an absolute manner that all the researches concerned the use of locomotives, but that they also concerned the use of small locomotives.

Mr. Quarré. (In French.) — I mention in my report that sixty-eight administrations, of the one hundred and fifty-two consulted by me, answered that there was nothing new to report and that very few researches had been made concerning the use of small locomotives or of automotor cars.

On the other hand, as regards the reduction of the staff, the driving of the train by one single man, etc., I have mentioned all the answers and in particular that made by the Orleans Railway, which runs as follows :

> The system is not yet used, but the methods of applying it are being investigated.

Be that as it may, I do not oppose, as I have already stated, that the words " ... nearly all the researches..." should be replaced by " ... most of the researches...", although the answers I received lead rather tot he wording " ... nearly all the researches..."

As regards the subject of having a smaller train crew, that could be made the subject of a separate clause in the conclusions.

The President. (In French.) — In the first place, I wish to remark that Mr. Quarré feels disposed to meet Mr. Jourdain's view by accepting his proposal that the words " ... nearly all the researches..." should be replaced by " ... many of the researches."

The question now remains whether you wish to retain this clause or whether you prefer to strike it out. I should like to add that in my opinion Mr. Jaggard's remarks also concern other points of operation, which have also been considered by the European administrations, but do not affect the clause we are at present considering; for that clause refers in particular to the traction and not to the signalling or other services.

Mr. Quarré. (In French.) — Indeed, it also refers to the other services.

The President. (In French.) — If anything is to be added, it would suffice to say : " In Europe ". The reporter stated that

he received no answers from America. Consequently, it is evident that the conclusion he proposes cannot concern America, but only Europe. I would ask the reporter whether he consents to the addition of these words.

Instead of striking out the second clause, it is a question of ascertaining whether it is advisable to make an addition by virtue of which the statement is limited to Europe.

Mr. Quarré. (In French.) — I have given the answers of the American railways which show that in the United States the laws and regulations affecting secondary railways are excessively strict, so as to increase the cost of the service unnecessarily; this prevents the adoption of any economic measures. Accordingly, it seemed to me that but little had been done to improve this service. Complaints are made that no facilities are possible, in consequence of the very regulations themselves.

The President. (In German.) — Do you adopt the addition proposed by Mr. Jaggard, that these researches were in Europe? (*Signs of approval.*)

This addition is accordingly adopted, and under these conditions the proposal for striking out the clause falls to the ground.

If nobody makes any further proposals, I declare that clause 2, worded as follows, is adopted :

" The attention of European railway administrations had been drawn specially to the use of automotor cars, and it was in this direction, in fact, that many of the researches for improving the service on these lines tended."

There is still clause 3, which runs as follows :

" According to the experience which has now been obtained, this solution will not lead to a general transformation of this service, and it would seem that it can only be ranked among economic methods applicable to particular cases, when there is a combination of favourable conditions. "

Mr. Francis Level, Anvin-Calais Railway, France. (In French.) — At page 38 of the report (1), it is stated :

It may be added that in spite of the attempts made to reduce the unit cost of small trains (light locomotives and carriages, automotor cars), the system of mixed trains is still recognized, in principle, as the most economic for the operation of local railways; in addition it makes it possible to accelerate the circulation of the goods stock.

We should all agree, I think, to this statement. Does the reporter see any disadvantage in including it among the conclusions? I propose to insert after the words " of this service ", the following : " nor to the elimination of mixed trains ".

Mr. Quarré. (In French.) — The railway administrations have always been trying to find means for keeping separate passenger trains and goods trains; nevertheless one tries to content the public, as this has indirect advantages. It would hence be regrettable to show a tendency in favour of mixed trains, which on the contrary it is desirable to ged rid of. That is why I have not mentioned them.

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(1) See also *Bulletin of the Railway Congress*, November, 1909, p. 1372.

Mr. de Burlet. (In French.) — You however praise them in that part of the report which is headed " Summary and Conclusions." One cannot think of eliminating mixed trains on economic lines generally.

Mr. Quarré. (In French.) — Certain administrations have tried to achieve such a separation, but as yet it does not seem that any saving has been effected. The system of mixed trains remains, in many cases, the most economic, but must we record this in our conclusions when our aim is the desirable separation of the passenger service and the goods service? That is the whole question.

The President. (In French.) — Does Mr. Level propose a definite text? If so, I request him to hand the bureau a proposal which can be put to the vote.

Mr. Serani. (In Italian.) — We are here considering lines having not much traffic or even very little traffic, on which mixed trains already exist. I think it is not advisable, from the point of view of economy, to propose to recommend the separation of the passenger service and the goods service.

The President. (In German.) — Mr. Level's proposal is opposed by Mr. Quarré. Now we have to arrive at a conclusion unanimously in order to submit it to the general meeting.

Hence, it seems to me advisable that Mr. Level should withdraw his proposal, the more so as the point is discussed in the report itself.

On the other hand, the Congress cannot adopt any conclusion which could, in some way or other, hamper the full freedom of the administrations to act in accordance with what special circumstances may arise.

Under these conditions, I think it would be best to adopt the original wording as it stands.

— Adopted (1).

The President. (In French.) — Does anybody wish to make any further proposal?

Mr. Leverve. (In French.) — I propose the addition of a clause to cover the point I have already raised, namely that not only have automotor trials been made, but also other researches which should be continued by the different administrations and which it is advisable to note. Accordingly I propose that the following clause should be added to the conclusions :

" It is desirable to continue the experiments made in order to obtain, by the use of small locomotives, either specially designed, or only modified, the advantages expected from motor cars, especially having one man only to drive the train."

That means to say, that as automotor cars have not given satisfactory results, at least to many administrations, there are other means of obtaining the same advantages as those expected from motor cars, namely a quick service and economy. There are in particular, I repeat, small locomotives either specially designed or only modified. Let us therefore mention this desideratum and the investigations made with this object in view.

(1) As shown below, the section reconsidered this vote and the addition proposed by Mr. Level was adopted.

Mr. Ulbricht. (In German.) — If this clause is adopted, I propose that it should be modified, that it should not mention the driving of the train by a single man, but only state : " the simplified driving ". Otherwise the wording would seem to me to be too narrow.

Mr. Machowetz. (In German.) — It is certain that the adoption of the principle of one man only on the locomotives on local lines would be advantageous as regards the reduction of working expenses. I think it would be advisable to have in the conclusions some mention of the advisability of continuing the investigation of the question of single-man driving. No doubt this system involves certain disadvantages what I have already mentioned. On lines where there are many level crossings without gates, or sharp curves, or sections where the outlook is limited, it is necessary for the driver to watch the track much more carefully. I will also ask what is to happen in case of sudden illness of the driver. In the case of single driving, the train would then continue to run on without being looked after. That is evidently a perilous case which requires consideration.

The President. (In French.) — I may remark that the question whether the engine can be driven by one man or two men has already been discussed. All that we can do, is to draw attention to the possibility of having a smaller locomotive crew.

Mr. Leverve. (In French.) — In order to meet the objection raised, one might say : " It is desirable to continue the experiments made in order to obtain, by the use of small locomotives, either specially designed or only modified, the advantages and the simplified driving expected from motor-cars."

This wish by no means implies the obligation of having one man only on the locomotive; it is self-evident that in many cases two men are required. But when it is a question of a simple service — as on many of the minor lines in France — it is possible to reduce the locomotive crew to one man.

The President. (In German.) — Will you kindly decide about the last proposal, definitely worded as it now is; does it meet with your approval, yes or no?

Mr. Quarré. (In French.) — The point seems to me at present a much-disputed one and as yet very few experiments have been made. Such being the case, would it not be simpler to omit it in the conclusions?

The administrations of the main railroads, in fact, are not making many trials concerning the use of small locomotives. On the other hand, the automotor cars are not designed specially to be driven by one single man; generally there are two men.

Mr. Ulbricht. (In German.) — For reasons of convenience, I recommend that the words " having one man only to drive " should be omitted, as several administrations are hostile to this system, and their hostility is perhaps justified. I would rather support the more elastic wording which I have proposed, which does not suggest the discontinuation of the investigation of the question of one-man driving, and in which the words " driving by a single man " are replaced by " simplified

driving ". I agree to all the rest of the wording.

The President. (In French.) — It is accordingly agreed that the administrations should be recommended to continue the experiments made in order to obtain, by the use of small locomotives or of modified locomotives, the advantages and the simplified driving expected from automotor cars. (*Approval.*)

Mr. Machowetz. (In German.) — I prefer the words " driving by a single man " to be retained, for they express the idea, intended by that wording, that a man can be saved, and if some administrations are hostile to this system, that is no reason for casting aside the question of making experiments. That is why I propose that the words " driving by a single man " shall be retained. In this way, we express exactly what we want.

The President. (In German.) — I would remark to Mr. Machowetz that such proposals only delay us. A little time ago this addition was rejected, and it was my impression that the section did not wish to open the question of the preference to be given to driving by a single man or driving by two men, and does not wish to recommend either the one or the other system. It is exactly for this reason that Mr. Ulbricht proposed a wording which is a little more general. The report is in everybody's hands and one knows in what directions simplification can be sought. But I think it would be difficult to come to an agreement if we specially mentioned driving by a single man. That is my general impression.

Mr. Machowetz. (In German.) — I simply thought that the direct statement " driving by a single man " would make the text more intelligible. But in the interests of simplicity, I withdraw it.

The President. (In German.) — Mr. Machowetz states that he agrees.

It is self-evident that it will be mentioned in the minutes that the simplified driving of the locomotives refers above all to reducing the locomotive crew from two men to one man.

After the explanations which have just been made, the section is unanimous in adopting Mr. Leverve's proposal, worded as follows :

" It is desirable to continue the experiments made in order to obtain, by the use of small locomotives, either specially designed or only modified, the advantages and the simplified driving expected from motor-cars."

— Adopted.

Mr. Maresch. (In French.) — I request permission to reconsider a detail in connection with the third clause.

Mr. Serani, in agreement with the French delegates, observed some little time ago that on lines with little traffic mixed trains were already in existence. He added that in his opinion the separation of the passenger service and the goods service was not advisable from the point of view of economy.

I hence request the section kindly to reconsider its vote, and I propose the adoption of Mr. Level's wording, which is as follows :

" According to the experience which has now been obtained, this solution will

lead neither to a general transformation of this service, nor to the elimination of mixed trains."

Everybody agrees to the statement that mixed trains already exist on lines with little traffic.

Mr. Quarré. (In French.) — It is said that " this solution will lead to neither the transformation of this service ". That implies that it will not lead to the elimination of mixed trains. The amendment hence seems to me to be unnecessary.

The President. (In French.) — It is agreed that clause 3 shall be worded as follows :

" According to the experience which has now been obtained, this solution will lead neither to a general transformation of this service, nor to the elimination of mixed trains, etc."

From all sides. — Yes, yes!

The President. (In French.) — That is accordingly adopted.

DISCUSSION AT THE GENERAL MEETING

Meeting held on 15 July 1910 (morning).

Mr. P. WEISSENBACH, PRESIDENT, IN THE CHAIR.

GENERAL SECRETARY : Mr. L. WEISSENBRUCH.

FIRST ASSISTANT GENERAL SECRETARY : Mr. MÜRSET.

SECOND ASSISTANT GENERAL SECRETARY : Dr. A. BONZON.

Mr. Dietler, *president of the 3rd section*, read the

Report of the 3rd and 5th sections meeting jointly.

(See *Journal de la huitième session*, No. 7, p. 7.)

" Mr. QUARRÉ (*reporter*) referred to the sad death of Mr. J. Rocca, reporter at the last session of the Congress, who had perished in the disaster at Messina. The meeting joined in the regrets expressed by Mr. Quarré. The reporter then mentioned that the subject of simplifying the operation of lines with light traffic had been frequently considered by the Congress. It did not seem that any new solutions had appeared since 1905.

" In his report, Mr. Quarré examined in succession the legislation and the application of measures suggested for facilitating the services on lines with light traffic, and he noted that hardly any changes had to be recorded. He then read the conclusions which he had drawn from the information received :

" Since the last session of the Congress, very few alterations have been made both in the legislative provisions and in the methods of economic operation of lines belonging to main railways but carrying little traffic.

" The attention of the railway administrations had been drawn specially to the use of automotor cars, and it was in this direction, in fact, that nearly all the researches for improving the service on these lines tended.

" According to the experience which has now been obtained, this solution will not lead to a general transformation of this service, and it would seem that it can only be ranked among economic methods applicable to particular cases, when there is a combination of favourable conditions."

" Mr. Campiglio (*Italian local railway Union*) described the experiments made on certain Adriatic and Mediterranean lines, by reducing the rates and simplifying the luggage service. The numbers of passengers had increased, but not the receipts, and the stamp duties had added to the State funds.

" Mr. de Burlet (*Belgian National Suburban Railway Company*) had during the last year been making trials with a petrol-electric car. They appeared to be satisfactory and his administration had ordered four cars of the same kind. He was of opinion that the question should again be placed on the agenda of the next session. It was probable that it would then be possible to give interesting particulars about the use of these cars.

" Mr. de Souza (*Portuguese State Railway*) stated that in Portugal the secondary lines were subjected to the same rules as the main lines. Cars with a steam motor on a separate bogie had been tried in order to develop the traffic on certain lines; but this system had proved inadequate.

" Mr. Jaggard (*Pennsylvania Railroad*) stated that conditions in America seemed different from those in Europe, as regarded facilities granted to secondary lines. In America there is no difference in the conditions. The requisite safety regulations are the same in the case of lines with light traffic as for the others. The public, on the other hand, asked for as many facilities on secondary lines as on the others, which results in unjustifiable expenditure.

" Mr. René Jourdain (*St. Quentin-Guise Railway, France*) stated that trials made with motor cars had not given results satisfactory from the economic point of view. Light-trains with locomotives weighing 10 to 12 tons were to be preferred.

" Mr. Ulbricht (*Saxon State Railway*) said that German legislation favoured secondary railways. Safety regulations were fixed according to the speed and density of traffic. As regarded facilities provided, these had at least to meet needs; but it could not be asked that they should be the same as those required in the case of main lines.

" Mr. Machowetz (*Austrian State Railway*) spoke about the Daimler, Serpollet and Komarek systems, which probably would not become applied more extensively, as the results had not been encouraging.

" Mr. Maresch (*Rumanian State Railway*) also expressed the opinion that the safety regulations should have to bear a relation to the speed.

" Mr. Quarré asked whether any one could give information about experiments with a view to diminishing the locomotive crews.

" Mr. Ulbricht stated that it had been tried, in Saxony, to have only one man on the locomotive, subject to the condition that the conductor should be able to stop the train, if anything happened to the driver. It was stated that a system of electric cars had been proposed and was being studied in Prussia, in which the train was stopped automatically as soon as the driver released the controller handle.

" Mr. Waechter (*Vering and Waechter Company, Germany*) stated that in Baden the locomotive could be driven by a single

man, if the line was on a separate roadbed and if there was intercommunication.

" Mr. Machowetz said that in Austria the conductor had to be able to stop the train if the engine was driven by one man only. But this system was not to be recommended in the case of a difficult line.

" Mr. Serani (*Italian State Railway*) stated that in Italy, on the Valteline and Milan-Varese main lines, with electric traction, there was only one driver; but the conductor had to know how to stop the train.

" The section then began to discuss the conclusions. With regard to the second clause, Mr. René Jourdain asked that the words " that nearly all the researches " should be replaced by the words " many of the researches ". He reminded the meeting that the reporter had also indicated other improvements, telephones, the closing of stations, etc., which had also been considered.

" Mr. Leverve (*Orleans Railway*) added that the reduction of the staff on the locomotives had also been tried as an economic measure.

" Mr. Dounine (*Vladicaucasus Railway, Russia*) stated that a saving could also be effected by simplifying the station services.

" Mr. Jaggard mentioned that in America economies had been attempted in the signalling system by substituting telephones for telegraphs, and by simplifying the construction of the track. He considered that clause 2° did not apply to the experiments made in America. He asked that it should be stated that this only referred to Europe.

" Mr. Francis Level (*Anvin-Calais Railway, France*) asked that it should be stated that " this solution will lead neither to... nor to the elimination of mixed trains ".

" Messrs. Maresch and Serani supported this amendment and remarked that in the case of lines with light traffic it was not economically advisable to have the goods and passenger services separate.

" — This amendment was adopted.

" Mr. Leverve proposed that the following additional clause should be added : " It is desirable to continue the experiments made in order to obtain, by the use of small locomotives, either specially designed, or only modified, the advantages and the simplified driving expected from motor-cars."

" Mr. Machowetz asked that it should be explicitly stated that it was desired to restrict the staff on the locomotive to a single driver on the lines with light traffic.

" The President remarked that the wording proposed did not exclude the application of Mr. Machowetz's idea.

" Mr. Leverve's proposal was adopted and added as clause 4°.

" The sections then agreed to submit the following conclusions to the general meeting."

The President. — The following are the

CONCLUSIONS.

" 1° Since the last session of the Con-
" gress, very few alterations have been
" made both in the legislative provisions
" and in the methods of economic opera-

" tion of lines belonging to main rail-
" ways but carrying little traffic.

" 2° The attention of European railway
" administrations had been drawn spe-
" cially to the use of automotor cars, and
" it was in this direction, in fact, that
" many of the researches for improving
" the service on these lines tended.

" 3° According to the experience which
" has now been obtained, this solution
" will lead neither to a general trans-
" formation of this service, nor to the
" elimination of mixed trains; and it
" would seem that it can only be ranked
" among economic methods applicable to
" particular cases, when there is a com-
" bination of favourable circumstances.

" 4° It is desirable to continue the ex-
" periments made in order to obtain, by
" the use of small locomotives, either
" specially designed or only modified,
" the advantages and the simplified driv-
" ing expected from motor-cars."

— These conclusions were confirmed by the general meeting.

SECTION V : LIGHT RAILWAYS

[625 .611] QUESTION XVIII

THE WORKING OF LIGHT RAILWAYS

Examination of the results of the different systems used in operating light railways (leasing, operating jointly with corresponding main railway, working by concessionary himself, with or without guarantee or subvention from the authorities granting the concession).

Reporter :

All countries. — Mr. Plocq, traffic engineer in chief to the Somme and Northern railways of the French General Light Railway Company.

QUESTION XVIII

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N. B. — See also the separate issues (in red cover) Nos. 10 and 58.

[625.611]

REPORT

By Mr. PLOCQ,

INGÉNIEUR CHEF DE L'EXPLOITATION
DES RÉSEAUX DE LA SOMME ET DU NORD DE LA SOCIÉTÉ GÉNÉRALE DES CHEMINS DE FER ÉCONOMIQUES FRANÇAIS.

The Permanent Commission of the Railway Congress has intrusted me with the mission of examining the results given by the different systems used in operating light railways.

These systems depend to some extent on the legislation in force. This question of the legislation was authoritatively investigated in 1905 by Messrs. Colson and Ziffer. It has nevertheless appeared to me necessary to give at the beginning of this report, a short summary of their report, laying some stress on the modifications and additions which have since been made in certain countries.

I. — GERMANY.

The legislations of the different States have, at various times, occupied themselves with the subject of light railways. But it is in Prussia alone that we find a general system of subsidies established by the act of 1892.

The *Kleinbahnen* (minor railways) are never incorporated in the State Railway system. Concessions are granted either to companies, or to districts, or to communes.

As a rule, the contribution of the State is equal to that of the provinces plus that of the districts, less the cost of land. It may amount to twice as much in the case of poor provinces, and as a rule takes the form of subscribing for bonds or preference shares.

*

Construction by the districts and provinces tends more and more to become the rule, the actual operation being left to special companies of great importance which have made a speciality of this work. One of the most important is the firm Lenz, of Berlin.

II. — AUSTRIA AND HUNGARY.

AUSTRIA.

In the Austrian Monarchy, the legislation about light railways shows much variety. There is a fundamental act of 1894; but a special act may intervene in each particular case. Assistance by the kingdoms or countries represented in the Reichsrath, is generally given under conditions similar to those adopted by the State.

In certain cases, the governments of the countries take direct charge of the concession, of the construction and even of the operation.

The financial assistance given may assume the following different forms :

1° The line is built by the country in consequence of a concession for construction and operation granted to the national delegation, or in consequence of a concession granted to the parties interested, or to a private company;

2° A guarantee is given for the payment of the interest and the amortization of the preference shares;

3° Loans on mortgage;

4° Subscription of fully-paid shares;

5° Subsidies paid outright (money not repayable);

6° The holding of enquiries and making of projects.

When the States gives a guarantee, it as a rule constructs and operates the line. When a country gives a guarantee of net profit, as a rule it constructs, and the State operates the line. Lower Austria also operates the lines which it has guaranteed.

HUNGARY.

In Hungary, the light railways can receive subventions from the State, the comitats, the communes and other interested parties. Concessions are granted to companies which undertake the financial organization and must supply at least 65 per cent of the capital, in the form of preference shares.

The State subvention consists, as a rule, in subscribing 10 per cent of the capital as ordinary shares, without conditions, and a further subscription of 10 per cent as a maximum in consideration of the free carriage of mails. The comitats, communes and other interested parties, take ordinary shares up to 15 per cent, as a maximum, of the capital. As a rule, the companies leave the operation to the State Railway.

III. — ARGENTINE REPUBLIC.

Indirect financial assistance can be given to light railways in the form of free grants of State lands.

IV. — BELGIUM.

The machinery for the organization of light railways in Belgium was created by the acts of 1884 and 1885. This is the *Société nationale des chemins de fer vicinaux* (National Light Railway Company), which is really a centralized public service.

Its distinguished general manager, Mr. de Burlet, is the creator of the light railways in Belgium.

Nobody can obtain a concession for a light railway unless that concession has been refused by the *Société nationale*.

The concession is granted by royal decree. The *Société* keeps separate accounts for each line. The shares are subscribed by the public (in actual practice, only in small part), by the State, as a rule, one half, and the rest by the provinces and the communes.

The *Société nationale* generally operates by leasing.

V. — GREAT BRITAIN AND IRELAND.

ENGLAND AND SCOTLAND.

The light railways are constructed under the act of 1896. They are under the jurisdiction of the Board of Trade. A special commission deals with them.

Financial assistance is regulated as follows :

County, borough and district councils can advance sums within the limits which, in the opinion of the Board of Trade, are suitable considering the interests concerned. These sums are in the form of a loan or of a subscription to part of the share capital.

The Treasury can also make advances at a rate of interest which is at least 3·20 per cent. Such advances cannot exceed one quarter of the total capital, nor can they exceed the total subvention given by the councils. At least half of the share capital must be subscribed by the public. The Treasury can, moreover, make special advances, without interest, if the authorities consider that a line presents special advantages, from an industrial and agricultural point of view. The total amount of the subsidies must not exceed 25 millions of francs (£1,000,000), 6 millions (£240,000) of which may be in the form of special advances.

IRELAND.

An act of 1880 had provided a State guarantee together with county guarantees for some of the lines. In 1889, the whole matter was regulated by the Light Railway Act. Capital can be contributed not only when the counties give a subvention, but also when an existing company undertakes to construct and operate the line. A fund of 15 million francs (£600,000) was placed at disposal for this purpose, and was increased by 12 $^1/_2$ millions (£500,000) in 1896, by an act which limited the assistance of the State to half the cost of construction, except in certain poor districts where the only condition is a reasonable contribution by the localities.

Mr. Colson recorded in 1905 that these different measures had enabled about 1,000 kilometres (620 miles) of light railways to be constructed. On examining the documents issued by the present parliamentary enquiry, we find that up till 1909 the situation was not altered.

VI. — BULGARIA.

In this country, there is no law on the subject of light railways. Moreover, the standard-railway system is not yet completed.

VII. — CHILI.

No financial aid is given.

VIII. — DENMARK.

The construction of light railways is regulated by the act of 1894 according to which the State contributes half the cost of construction.

The provinces take up the shares or bonds of the companies. The concessionaries build and operate the lines themselves.

IX. — EGYPT.

The government grants permission for the utilization of the roads and for the gratuitous occupation of State lands.

It guarantees a net return of 900 francs per kilometre (£58 per mile) applying a coefficient of working of 60 per cent to the gross receipts. This guarantee is of very little value, for it does not apply unless receipts are below 2,250 francs (£145 per mile).

X. — SPAIN.

The light railways in Spain are regulated by the act of 30 July 1904 and by the order of the public administration of 2 November 1905.

As this legislation could not be considered at the last session of the Congress, we give particulars, in some detail.

The act consists of three chapters :

The first deals with the general conditions of existence of the light railways, concessions for which can only be granted to Spanish companies. It regulates the relations between the concessionaries and the different ministerial departments.

The second chapter deals with railways for which concessions are granted without State subventions. These can occupy certain parts of the State lands, utilize its works as well as those of the provinces and the municipalities, and be free from the taxes levied on the carriage of passengers and goods. The Minister of Public Works grants these concessions, and submits the matter to the chambers if State land is to be occupied or there is to be expropriation.

The third chapter deals with railways for which concessions with guarantee of interest by the State, are granted.

A commission under the Minister of Public Works is entrusted with the task of drawing up projects for such lines, which must not, altogether, exceed 5,000 kilometres (3,100 miles) in length, and are in groups, each of which must in principle not have less than 200 kilometres (124 miles).

These lines, in the first place, benefit by the same advantages as the non-subventioned lines.

In addition, the State guarantees the capital required for construction, rolling stock not included, a minimum rate of interest of 4 per cent for twenty years. The capital guarantee cannot exceed 50,000 pesetas per kilometre (£3,219 per mile).

The annual working expenses must not exceed 3,000 pesetas (£193 per mile). The control of the expenditure and the drawing up of the annual accounts are carried out according to special forms. When the net profit exceeds 8 per cent, the State receives half the surplus for the repayment of its advances.

If ten years after the operation of a line has begun, the State still has to make advances, the Minister can appoint a delegate to act as joint manager of the concessionary company.

The act leaves to private initiative the study of the technical conditions of construction and of the operation of the groups. The government then puts the concession for each of them up to auction. Conditions are made as to the capital to be guaranteed, the period during which the concession is to run, and the working coefficient.

When provincial or municipal councils are to undertake, either separately or jointly, the construction of the whole or of part of the system they are interested in, the government gives them the preference over any other concessionary, provided that they undertake the whole or part of the interest guarantee.

The concessionaries have to pay to the author of the approved project the cost of the initial expenses, which must not exceed 500 pesetas per kilometre (£32 per mile)

The act provides for repurchase at the expiration of the interest guarantee; the annuity to be paid till the termination of the concession is calculated from the average profit of the last five years.

If this annuity corresponds to a rate of interest, on the capital invested, of more than 8 per cent, the earlier instalments are reduced by half the surplus until the advances made by the State have been repaid.

XI. — UNITED STATES OF AMERICA.

The term " light railways " is very seldom used in the United States.

The minor lines are, as a rule, constructed with the assistance of the main lines to which they act as feeders.

The States assist. Sometimes, the countries and districts as well as the large land owners and business interests assist by money subventions or grants of land.

Some of the States have legislation on the subject, others not.

XII. — FRANCE.

The light railways and tramways in France are regulated by the act of 1880; the main object of this act was to substitute subventions in the form of annuities for the subventions in the form of capital, which were granted under the act of 1865.

The railway systems are organized by the departmental authorities. The department generally deals with a company, either for the concession of the lines or for their leasing. It is the department alone which makes the contract with the concessionary; it is the department alone which enters into negociations with the State and the communes, in order to obtain their assistance before the declaration of public utility is issued, after approval by the Council of State, on the proposals of the ministers of the Public Works, of the Interior and of the Treasury.

The State subvention cannot increase the dividends on the construction capital to more than 5 per cent. It cannot exceed that of the parties interested, namely the department, the commune, and the public. It cannot exceed two maxima, calculated by kilometre and in proportion to the gross receipts. The department can itself undertake the operation; but this as yet has only been done provisionally.

One department operates through the intermediacy of the State Railway.

In June 1908, Mr. Barthou, minister of Public Works, presented a bill to amend the act of 1880.

The preamble of the bill contains very interesting information on the light railways and tramways of France.

The principal provisions of this project are as follows :

The distinction, which is frequently very artificial, between " railways of local interest " and " tramways " is abolished. The procedure in connection with the

concession and the enquiries is simplified and made more practical. The declaration of public utility is made by decree and no longer requires an act.

The subvention of the State, as before, cannot exceed the contributions made by the department and the communes, including those made by the public. No subvention is given by the State, if the traffic is insufficient. As a matter of fact, it may be stated that the departments do not do more; any railway which cannot even pay its working expenses appears useless, except in particular cases in which the department undertakes the whole business alone. The bill regulates the question of the maximum subvention given by the department, and specifies the different ways in which such subvention can be made. The construction capital is calculated either on the basis of the real and properly justified expenditure, or according to a system of a series of rates.

The working expenses are calculated, either on the basis of their actual amount, or according to a formula which takes into consideration the receipts, the number of the trains, and, the case arising, the importance of the traffic. The preamble lays special stress on the importance of taking into consideration the number of trains. In order to promote the development of the traffic, which necessitates an increase in the number of trains, it is necessary to allot the concessionary a sum which covers, not the whole cost of those trains, but that part of that cost which is not covered by the fraction of the receipts, which according to the formula goes towards working expenses. The concessionary cannot be an individual person, but must be a corporate body or company.

XIII. — DUTCH INDIES.

Regulations issued in 1893 enabled the light railway system, which only included 281 kilometres (175 miles) in 1893, to grow to 1,900 kilometres (1,180 miles) in 1900.

These regulations do not provide for any subvention, but regulate the use of the public roads and grant facilities of construction subject to the condition of limitation of speed; this as a rule must not exceed 25 kilometres (15·5 miles) per hour.

The operation is by concessionary companies.

Four of the chief ones, although quite distinct, have a joint management, and every employee is bound to accept from the management an appointment in any one of the companies concerned. This regulation does not apply to the lower-grade employees.

XIV. — ITALY.

The light railways are regulated by the act of 1896.

The scales of rates fix in each case the maximum tariffs and the measures necessary for combining safety of working with reasonable economy.

The act specifies that no guarantee of kilometric receipts can ever be given, and that the operation is to be by private parties.

The State can participate in the cost of construction by making kilometric subventions. The 1873 act specified that the annual subvention per kilometre must not exceed 1,000 francs (£64 per mile). This maximum was raised by other acts to 6,000 and to 8,000 francs (to £386 and to £515 per mile).

The provinces, communes and other bodies can give subsidies, preferably in the form of a subvention per kilometre, under conditions specified in an act of 1894; but the Council of State has power to modify these conditions.

An act of 1907 has given powers to increase up to 5 million lire (£200,000) the total subventions given by the State to railways for which concessions have been granted to private parties. It has also given powers to grant, for a term of not more than thirty years, subventions up to 2,000 lire per kilometre (£129 per mile) for the construction of tramways connecting important places with the railway stations.

XV. — NORWAY.

The State grants assistance to light railways, but there is no general law regulating the matter. Each subvention is the subject of a special act.

The contribution of the State generally represents half the cost of construction. The construction is carried out by the concessionary. The operation is by a council of administration appointed by the parties interested. The State reserves the right of appointing one of its members.

XVI. — HOLLAND.

Financial assistance is given by the State, the provinces and the municipalities.

Every subvention is the subject of a special act. Some of the provinces have issued regulations as to their contributions.

The financial assistance takes the form of an advance without interest, of a loan bearing interest, of participation in the capital.

The State, the provinces and the municipalities never undertake the operation, which is either by the concessionary or by the main-line railways.

XVII. — PORTUGAL.

An act of 14 July 1899 regulates, in a general way, the assistance given by the State and the corporations to the lines supplementing and feeding the State Railway system.

This act establishes a special fund for carrying out new work on the State system, and also for studying and constructing lines supplementing and feeding that system.

The facilities given are as follows :

1° Admission of materials and rolling stock duty-free;

2° Free carriage on the State lines of the materials used in building the lines ;

3° Annual subvention during thirty years equal to 50 per cent of the net receipts brought to the State system by the feeder lines;

4° Authorization to the municipal councils to pay the cost of expropriation;

5° Authorization to the juntas to levy as subsidies for the undertaking additional taxes, to an extent not exceeding 3 per cent of the latter;

6° Authorization of charging rates 40 per cent higher than those of the State Railway;

7° Exemption for thirty years from stamp and transport duties;

8° Exemption during thirty years from the tax on shares.

In March 1904, a bill was submitted creating a special fund for the railways in the central zone. — This bill increases the facilities granted by the act of 1899 and provides for guarantees of interest.

It has been made the subject of favourable report at the Cortes, but has not yet been passed.

In 1906, regulations were issued concerning railways on high roads.

Before and after 1899, concessions were granted for a certain number of light railways by special acts, with subventions of various kinds, including guarantees of net profit and of interest.

XIX. — RUMANIA.

The light railways are regulated by the act of 1898. There is no financial subvention. The lines are entitled to the gratuitous possession of State and Crown lands, and have indirect advantages and great facilities for operation.

XX. — RUSSIA.

The act of 10 June 1905, passed after the Russo-Japanese war, makes the first reference to light railways.

This act, which applies to private capital for the reorganization and extension of the national railway system, and regulates the different modes of the public treasury, contains a paragraph worded as follows :

In the cases of lines which are only of local importance, or which will be constructed at the personal cost of the promotors, capital will be advanced by the Treasury under given conditions.

XXI. — SERVIA.

Acts of 1898, 1899 and 1902 provide for a system of lines which can either be constructed by the State, or for which concessions can be granted. No financial

subventions are provided, but there are indirect advantages of various kinds, including the right of working mines within a certain distance.

XXII. — SWEDEN.

The public authorities, the general councils, and the municipalities can give financial assistance and actually do so, but there are no general legal provisions in existence.

The assistance consists in the subscription to ordinary and preference shares by the different bodies. The State and the provinces guarantee bonds.

Construction and operation is as a rule carried out by the concessionaries.

The State operates one line.

Ten lines are operated by neighbouring main-line railways.

XXIII. — SWITZERLAND.

The light railways are regulated by the federal act of 1899.

A light railway (*Sekundärbahn, chemin de fer secondaire*) is defined as a railway not utilized for through passenger and good services.

The Federal Council grants concessions for all railways and determines their character.

Nothing prevents a line from changing its character during the course of its working.

The Federal Council gives no subventions for the construction of secondary railways. The cantons can on the contrary give subventions underce rtain conditions and within the limits fixed by their own laws. The operation is as a rule by companies and the subvention is given in the form of a subscription, by the canton, to part of the company's capital.

The Rhetian Railway has received a subvention in a special way, not only from the canton (the Grisons), but also from the Federation.

XXIV. — TURKEY.

All the railways of this country may be considered light railways. As a rule, the State grants free land and a guarantee of gross receipts; this enables the concessionaries to raise the capital and to issue bonds which are secured, by the government, on certain revenues.

ANALYSIS OF THE ANSWERS AND OF THE DOCUMENTS.

Having given an account of the legislation in the principal countries, we will now proceed to consider the question set by the Congress, which we have amplified as shown by the list of questions which is given in an appendix. We have received very few complete answers. Below we give a summary of those which we have received and of the documents which we have been able to procure.

I. — GERMANY.

Although there are many light railways (*Kleinbahnen*) in Germany, we were unable to obtain any information from the people operating them.

The State Railways informed us that they did not operate any light railways; the companies operating them do not belong to the Congress. Our personal enquiries led to no result; we were always received courteously, but could obtain no information. It is evident that those concerned do not wish the results of the working known.

We are therefore only able to give a summary of the documents published by the *Zeitschrift für Kleinbahnen* and analysed by the *Revue des chemins de fer* :

It should first of all be noted that there are in Germany 5,690 kilometres (3,535 miles) of narrow-gauge lines, which are classed, by the Imperial Railway Office, as main lines; of them 2,870 (1,783 miles) are State lines, and 2,820 kilometres (1,752 miles) company's lines.

The average cost of construction of those lines, per kilometre, was 82,648 marks (£6,647.18*s*. per mile) in the case of the State lines; and 69,355 (£5,580.14*s*. per mile) in that of company's lines.

The receipts and expenses in 1906, per kilometre, were 6,126 and 5,239 marks (£492.18*s*. and £421.11*s*. per mile) in the case of State lines, and 7,627 and 5,298 marks (£613.14*s*. and £426.6*s*. per mile) in that of company's lines, respectively.

The net profit from working earned on the capital outlay was from 0·63 to 1·63 per cent in the case of State lines, with an average of 1 per cent. In the case of the companie's lines the average was 3·34, the mean of both together being 2·33 per cent.

The *Kleinbahnen* are of two kinds, tramways proper and light railways; and it is only the latter that we are considering.

In December 1907, there were in Prussia 247 undertakings of this kind, having a total length of 8,351 kilometres (5,189 miles); in the other States there were 16 such undertakings, with a total length of 373 kilometres (232 miles).

If we remember that at the time when the *Kleinbahnen* act was passed (1892),

such railways had in Prussia a total length of 159 kilometres (99 miles) only, we see how much development there has been under this act.

In Prussia :

50 per cent of these lines have a gauge of 1·435 metres (4 ft. 8 1/2 in.);
19 — — — — — of 1·00 metre (3 ft. 3 3/8 in.);
15·4 — — — — — of 0·75 — (2 ft. 5 1/2 in.);
4·1 — — — — — of 0·60 — (1 ft. 11 5/8 in.).

11 per cent of these lines have various gauges.

In Prussia, 161 lines were built by companies. The communes only built 79, with a total length of 3,075 kilometres (1,910 miles). As Mr. Colson has explained, the working is not in the hands of the owners. It has the character of an industrial enterprise.

The staff employed in Prussia included :

5,074 higher-grade employees;
6,464 lower-grade employees.

In other States, it included :

213 higher-grade employees;
134 lower-grade employees.

The total receipts increased in 1906, as compared with the previous years, by 4·21 million marks (£210,500) or 13·1 per cent in Prussia, and by 4·35 million marks (£217,500), or also 13·1 per cent, in the whole of Germany.

The working coefficient for the whole of Germany has increased from 67·1 to 67·3 per cent.

Calculated in marks per kilometre of line operated, the working results in 1906 were as follows :

	Receipts, per kilometre (per mile). Marks. (£ s.)	*Expenses, per kilometre (per mile).* Marks. (£ s.)	*Net profit, per kilometre (per mile).* Marks. (£ s.)
Prussia	4,729 (380.10)	2,923 (235. 4)	1,543 (124. 3).
Other states.	7,925 (637.14)	5,472 (440. 6)	2,453 (197. 8).
Mean for Germany.	4,798 (386. 1)	3,227 (259.13)	1,562 (125.13).

The capital expended on light railways amounted in 1906 to :

Prussia. . . . . 483,598,951 marks (£24,179,947.11*s.*).
Other states . . . . . 11,260,002 — (£563,000. 2*s.*).
The whole of Germany. 494,858,953 marks (£24,742,947.13*s.*).

In Prussia, the mean cost per kilometre was : 78,138 marks (£6,287.8*s.* per mile) for the standard-gauge lines and 47,892 marks (£3,853.13*s.* per mile) for the narrow-gauge lines.

The capital is made up as follows :

In Prussia the capital was contributed :

By the State (subvention fund) . . .	72,509,761 marks	(£3,625,488. 1*s.*)
— provinces	60,558,562 —	(£3,027,928. 2*s.*)
— districts	105,597,624 —	(£5,279,881. 4*s.*)
— promoters	54,189,668 —	(£2,709,483. 8*s.*)
Miscellaneous	190,743,336 —	(£9,537,166.16*s.*)

In the other German states, the capital for the light railways was contributed :

By the States	3,713,586 marks	(£185,679. 6*s.*)
— districts	296,000 —	(£14,800.)
— promoters.	1,023,824 —	(£51,191. 4*s.*)
Miscellaneous.	6,226,592 —	(£311,329.12*s.*)

We can give figures as to the results obtained by 216 undertakings in Prussia :

16 earned no dividend;
36 earned one of up to 1 per cent;
55 earned from 3 to 4 per cent;
15 earned from 4 to 10 per cent;
4 earned more than 10 per cent.

3,018,425 marks (£150,921.5*s.*) were distributed as dividends, or 550,000 marks (£27,500) more than the previous year.

Ten railways distributed a dividend of more than 5 per cent; 33, a dividend varying between 3 to 5 per cent; and finally, 29, a dividend of less than 3 per cent.

II. — AUSTRIA AND HUNGARY.

AUSTRIA.

Administration of the State Railway.

The Minister of Railways states that at the end of 1907, there were 104 light-railway concessionary companies who had their lines operated by the State Railway. The total length of these lines is 4,220 kilometres (2,622 miles), 385 kilometres (239 miles) being of narrow-gauge.

The different kinds of concessions granted provided for the assistance of the State, of the countries, of the districts or the parties interested, in order to guarantee interest or to help to raise the capital. The two methods : participation in the capital and guarantee of interest are in practice, combined in such a way that some of the parties named above assist in contributing the capital while others guarantee the interest on the preference shares. The line is built either by the concessionary or by the Administration of the State Railway.

The stores are charged to a special fund, and remain the property of the local

company. The rolling stock, also the property of the local company, is built to designs approved by the Minister. In case of temporary shortage, the State supplies stock on hire, against payment. It has an absolute right of disposal and of user of the stock of the local company, without any payment.

The cost of extending stations to accommodate local railways is paid by the latter. The local company has the right of using, for its lines, all the appliances at the joint station; but the land acquired and installations made become wholly the property of the operating administration. Nothing is paid for the right of user, as long as the annual receipts of the company are not sufficient to pay the interest fixed for the preference shares. When this figure is attained, the local company contributes to the payment of the interest of the capital outlay on the station in proportion to its share of the traffic.

All the subsequent expenditure is shared in the same way,

The tariffs fixed by the scale of rates can be reduced by the operating administration, to a minimum fixed by the convention. The financial arrangements concerning the working are made in various ways :

1° The operation is carried out subject to the payment of specialized expenses. The general expenses and the non-specialized expenses are paid in accordance with a formula mutually agreed on. As long as the fixed interest on the preference shares is not paid, all the reductions legally possible are granted to the local company ;

2° One part of the gross receipts is handed over by the local company;

3° The operating administration receives either a fixed sum per kilometre or a fixed lump sum.

The Minister considers that the local companies having their lines operated by the State Railways have the following advantages :

a) Right of user of the joint stations, subject to their eventual extension;

b) Operation by a staff which is properly trained;

c) In case of temporary increase of traffic, the local company is supplied by the operating administration with the necessary rolling stock and extra staff, without having to contribute to the cost entailed by the provision of such a reserve.

The Administration of the State Railway, by specializing the staff managing the light railways, has reduced the coefficient of working to 50 per cent.

Austrian North-Western and South-Northern Company.

The company operates several light railways for their owners on one of the following bases :

1° Paying the operating company a percentage of the gross receipts, starting from a certain minimum ;

2° Payment of the cost of working.

In consequence of the continual growth in the working expenses, the first system

has not given satisfaction. In the future, no agreements will be made with light railways except on the basis of payment of the cost of working.

Bukovinia Light Railway.

The Bukovinia Light Railway Company has a system of 217 kilometres (135 miles), which was built with the assistance of the Austrian State Railway and the Lemberg-Czernowitz Railway Company. One part of the system was operated by the Lemberg-Czernowitz Company until 1907, and then by the State, when it took over that railway. The other part was always operated by the State. The operation by the State is carried out under the conditions mentioned in the answer of the Minister of Railways, analysed above.

The company asserts that operation by the State tends to cost more than separate operation, but that it is necessitated because the system is in two separate portions. The company states : " If we operated the line ourselves, we would be able to reduce the cost of maintenance of the line, the cost of the station working and of the trains. On the other hand, the cost of maintenance of the rolling stock would increase, as the workshops necessary would not be fully occupied. The cost of management and of offices would also be greater ".

Under these conditions, the company considers the method of working adopted, as advantageous both to itself and to the State; it is also a great advantage to the public owing to the facilities for the exchange both of passengers and of goods.

The company states that the operation contracts enable them to exercise sufficient regulating influence on the fixing of the traffic, on station extensions and station working, and on the increase of rolling stock.

The working results, in kronen per kilometre (per mile), were :

YEAR	Receipts.	Expenses.	Net profit.
1900	10,453·81 (£693.17*s.* 1·56*d.*)	5,486·72 (£367.6*s.* 5·33*d.*)	4,967·09 (£332.10*s.* 8·23*d.*)
1901	10,145·77 (£679.4*s.* 8·16*d.*)	5,358·04 (£358.14*s.* 1·78*d.*)	4,787·73 (£320.10*s.* 6·38*d.*)
1902	10,281·12 (£688.5*s.* 10·88*d.*)	4,537·27 (£303.15*s.* 2·14*d.*)	5,743·85 (£384.10*s.* 8·74*d.*)
1903	11,731·19 (£785.7*s.* 5·74*d.*)	4,833·64 (£323.12*s.* 0·03*d.*)	6,897·55 (£461.15*s.* 5·71*d.*)
1904	11,747·48 (£786.9*s.* 3·48*d.*)	5,460·72 (£365.11*s* 7·58*d.*)	6,286·76 (£420.17*s.* 7·90*d.*)
1905	11,648·44 (£779.16*s.* 8·16*d.*)	4,625·25 (£309.12*s.* 11·75*d.*)	7,023·19 (£470.3*s.* 8·41*d.*)
1906	13,024·86 (£871.9*s.* 7·65*d.*)	5,610·01 (£375.11*s.* 6·28*d.*)	7,414·85 (£496.8*s.* 1·37*d.*)
1907	13,754·80 (£920.16*s.* 11·89*d.*)	7,540·18 (£504.15*s.* 11·10*d.*)	6,214·62 (£416.1*s.* 0·79*d.*)

HUNGARY.

Administration of the Hungarian State Railway.

The Hungarian State Railway in 1907 operated altogether 16,240 kilometres (10,091 miles) of railway lines, 8,111 kilometres (5,040 miles) of which were light railways.

The latter can be classified under four heads :

1° Five lines of 298 kilometres (185 miles) are operated on account of the State Railway. The State Railway pays the companies either an annual fixed rental, or annually the amount of a supplement levied on the transport rates. This is quite a special system of operation limited to exceptional cases;

2° 69 kilometres (43 miles) are operated on account of the owners who pay the real working expenses plus 10 per cent;

3° Eight lines, 330 kilometres (205 miles) long, belonging to the State;

4° One hundred and five lines, length 7,744 kilometres (4,812 miles), belonging to concessionary companies and operated on the " standard contract " basis. It is these lines, forming the greater part of the system, which present the most interesting features. The " standard contracts " are made for a period of ninety years. At first the standard contract provided that the working expenses should be paid on the basis of kilometre rates fixed in advance for every actual conveyance of passengers and of goods. After the zone tariff was established, and extended to the light railways, it became necessary to modify the standard contract.

The amount to be paid to the State was fixed for passengers, luggage and goods at 50 per cent of the receipts derived therefrom.

Several contracts have been modified on the basis of a fraction of the receipts :

In kronen per kilometre (per mile) :

the mean receipts were	5,845 kronen	(£391. 6*s.*),
the mean expenses were	2,932 —	(£196. 6*s.*),
and the mean profit	2,551 —	(£170.16*s.*).

In 1907 :

the total expenses were	29,273,024 kronen	(£1,217,757.16*s.*),
the total receipts were.	19,775,662 —	(£822,667.11*s.*),
The difference. . .	9,497,362 kronen	(£395,090. 5*s.*),

chargeable to the State, represents an annual working subvention of 1,226 kronen per kilometre (£82.1*s.* per mile).

The concessions for the lines were granted under the following conditions :

The amount of capital is fixed in the concession. The stock which the companies have the right to issue consists as a rule of ordinary shares, to the extent of 35 per cent of the capital, and of preference shares, to the extent of 65 per cent, of

the capital. The State, as subvention, subscribes up to 20 per cent of the capital in the form of ordinary shares, the remainder being subscribed by the parties interested, namely the comitats, the communes and the public, the latter generally only to a slight extent. The ordinary shares receive no dividend until 5 per cent has been paid on the preference shares.

Out of a total capital of 639,871,600 kronen (£26,618,658), there are :

443,449,300 kronen	(£18,447,490)	in preference shares;				
196,442,300	—	(£8,172,000)	in ordinary shares;	of the latter		
79,184,120	—	(£3,294,060)	were subscribed	by the State;		
46,696,620	—	(£1,942,580)	—	—	—	comitats;
36,798,990	—	(£1,530,838)	—	—	—	by the towns and communes.

The lines were built by the concessionaries on the basis of projects approved by the government.

The additional tracks and track appliances at the joint stations are constructed by the engineers of the State Railway.

The estimates serving as basis for determining the capital, provide a certain sum for the locomotive power required during the first few years of working. This sum is paid to the State which supplies the locomotive power and the rolling stock necessary for the service, in consideration of an annual payment fixed at 10 per cent of the receipts which the State receives every year for operating the line. Interest at the rate of 5 per cent on the lump sum paid for the company, is deducted from this payment.

In the case of narrow-gauge lines, the rolling stock is supplied out of the original capital. There are however only five such lines, having a gauge of 0·76 metre (2 ft. 6 in.).

The light railways operated by the State Railway form by far the greater part of the secondary railway system.

While those which we have just considered represent a capital of 639,000,000 kronen (£26,582,400), the capital of the independent lines is less than 10 per cent of this amount.

As we have seen, the operation of the light railways means a considerable loss to the State Railway. This loss is a subvention which the State readily grants these lines, many of which would not have been built and could not exist without such assistance. These lines, however, act as feeders to the State Railway which recovers part of its loss by the increase in receipts.

III. — BELGIUM.

All the details in connection with the working of the *Société nationale des chemins de fer vicinaux* have been explained at the last session of the Congress, and a summary of them has been given in the first part of this report. We cannot, moreover,

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do better than to refer our readers to the work published by Mr. de Burlet, in 1907, which is an absolutely complete treatise on the subject.

The *Société* does not itself undertake the operation, except when a line is to be opened by sections, or when nobody has taken it up and when a favourable time is awaited for leasing it. This is a very exceptional case for, in 1907, out of 133 lines with a total length of 3,095 kilometres (1,923 miles), there were only 5, length 168 kilometres (104 miles), to which this applied.

Leases are granted on the basis of a general contract, supplemented by special clauses forming a special contract for each line.

IV. — GREAT BRITAIN.

The English railways have not supplied us with any documents which throw any light on the subject which we are considering.

The only information we were able to collect were the reports published in the *Zeitung des Vereins* and the *Revue des chemins de fer.*

At the end of 1906, the total number of concessions ("orders") that had been applied for was 520, for a total length of 7,150 kilometres (4,443 miles), and a total outlay of 877,000,000 francs (£35,080,000), in accordance with the act of 1896, which has been very difficult of application.

Light railways are of three classes :

Class A includes the lines on a special roadbed, as a rule with steam traction, and of an agricultural character;

Class B includes lines on roads and highways, as a rule with electric traction, and intended to carry passengers;

Class N includes the lines belonging neither to class A nor to class B.

Only in the case of class A are subventions given. 189 applications, for a total length of 3,762 kilometres (2,338 miles), belong to this class. 124 schem were approved by the Commission; 116 came before the Board of Trade.

255 applications, for a total length of 3,086 kilometres (1,918 miles), belong to class B. 132 were approved by the Commission and came before the Board of Trade.

Out of 27 applications, belonging to class N, 7 were approved and came before the Board of Trade.

If we examine the progress of the application of this act, we find that of late the number of applications has become reduced and that up to the end of 1906, the Board of Trade had granted orders for the construction of 2,783 kilometres (1,729 miles); but of all these lines only 885 kilometres (550 miles) have actually been opened to traffic, and this shows the comparative failure of the act.

This want of success appears to be due to costliness of construction, resulting from the cost of work, the habits of the engineers and the requirements of the authorities.

The Board thinks that it is possible to improve the state of affairs, and to construct many lines which are wanted, if certain provisions of the 1896 act are modified, and if the lines receive subsidies from the State, the counties and the parishes interested.

V. — DENMARK.

The Danish State Railway states that it operates two light railways : one of 38 kilometres (24 miles) and one of 16 kilometres (10 miles).

In the one case, the State contributed 10,700 kroner per kilometre (£964 per mile), in the other half the capital.

VI. — SPAIN.

Spain has not supplied us with any information. The railway act is as yet too recent to have produced any result.

VII. — FRANCE.

We extract the state of affairs, as concerning light railways on the 31 December 1906, from the preamble of the bill presented in 1908.

At that time there were in existence in France 12,196 kilometres (7,578 miles) of light railways, if we include among light railways the overground tramways carrying both passengers and goods.

CLASS.	Length in kilometres (in miles).	Cost per kilometre (per mile).
A : Railways, act of 1865	1,029 (639)	129,818 francs. (£8,356.14*s.*)
B : Railways, act of 1880	6,263 (3,892)	69,983 francs. (£4,505)
C : Tramways for passengers and goods of all kinds . . .	4,906 (3,048)	53,809 francs. (£3,463.17*s.*)

The financial results obtained in these three classes were :

CLASS.	Cost of construction.	Gross receipts.	Working expenses.	Net receipts.	Dividends.
A	133,582,253 (£5,343,290.2*s.*)	8,919,929 (£356,797.3*s.*)	6,116,990 (£244,679.12*s.*)	2,802,939 (£112,117.11*s.*)	2·10
B	438,302,692 (£17,532,107.14*s.*)	22,927,341 (£917,093.13*s.*)	17,832,979 (£713,319.3*s.*)	5,094,362 (£203,774.10*s.*)	1·16
C	263,986,118 (£10,559,444.14*s.*)	18,337,352 (£733,494.2*s.*)	15,482,152 (£619,286.2*s.*)	2,855,200 (£114,208)	1·08

We analyse below the different answers received, which are unfortunately but few in number.

Administration of the State Railway.

This administration operates the standard-gauge light railway between Ligré-Rivière and Richelieu in the Indre-et-Loire department, and the 1-metre (3 ft. 3 3/8 in.) gauge mechanical-traction system of tramways of the Vendée department.

The Ligré-Rivière to Richelieu line is operated on a system such that the operator runs no risk of loss nor chance of gain.

The Vendée system has a length of 210 kilometres (130 miles).

The system of working is as follows; the operation is at the risk of State Railway; the expenses per kilometre are fixed on a scale of $750 \frac{2 \times R}{3}$, with a minimum of 2,200 francs (£142 per mile) and a premium of one third of any saving effected; any resulting new profit is in the first place applied to pay off the deficit account, and the surplus goes to the department. When the net profit the department receives exceeds 4 per cent, the surplus is equally divided between the State Railway and the department. The operator forms a reserve fund, not exceeding 3,000 francs per kilometre (£193 per mile), which remains his property.

Orleans Railway Company.

The Orleans Railway Company states that it holds concessions for 318 kilometres (198 miles) of 1-metre (3 ft. 3 3/8 in.) gauge lines which it leases to three companies who themselves built the lines on plans agreed upon, and for the account of the Orleans Company. The latter supplied the rolling stock, the fittings and the tools, of patterns jointly agreed upon.

The results of this leasing appear advantageous; on the one hand, it was possible to arrive at an economic method of operation; on the other, the public benefits by the agreement between the great and the small line, as all transhipment charges are eliminated.

The leasing companies keep accounts of receipts and expenses. The expenses account is increased by 5 per cent to cover the cost of the central administration, and by 150 francs per kilometre (£9.13 *s.* per mile) per year to cover the renewal of the line and the rolling stock, and to meet unexpected expenses.

Any losses are charged to the Orleans Company if the receipts are less than 2,600 francs (£167 per mile); the expenses must not exceed this figure.

If the expenses are less than 2,600 francs (£ 167 per mile) the profit if any, goes to the lessee. Beyond that, it is divided between the lessees and the Orleans Company.

Côtes du Nord Railway Company.

This administration operates 222 kilometres (138 miles) constructed by the department to which it supplied the rolling stock. The company supplied one quarter of the cost of construction to the department. This capital pays interest and is repayable by annuities. The system has, on the whole, been satisfactory, but the result depends very much on the ability of the engineer to whom the department entrusts the construction, as his authority is absolute. The company desires that the lessee should have a voice in the drawing up of projects, with arbitration in in case of disagreement, and that matters should be arranged by a commission appointed by both parties.

Landes Railway Company.

This company operates a system of 215 kilometres (134 miles), which it built itself. The capital is guaranteed by the Midi Railway Company which supplies the rolling stock, against hire, and exercises a supervision in order to improve the returns. The lines in question act as feeders to the Midi Company, so that not only have the returns of the lines themselves to be considered, but also the traffic they bring the Midi.

Tarn Department Railway Company.

This company operates 89 kilometres (55 miles) which it has constructed; the interest and amortization are paid by the department. It has no subvention and operates on the formula $1{,}000 + {}^{3}/_{4}$ R, with $^{2}/_{3}$ of savings effected. No opinion is expressed as to the results obtained.

VIII. — ITALY.

We have received no answer of any interest. Certainly the 1907 act has not yet been able to produce any effect.

IX. — DUTCH INDIES.

The government of the Dutch Indies states that the questions of leasing and joint working have not arisen, for the State and the different railway and tramway companies only operate lines they themselves have constructed.

On 31 December 1905, there were 1,899 kilometres (1,180 miles) of light railways in existence, most of them having a gauge of 1·067 metres (3 ft. 6 in.).

The cost of construction varies between 151,000 florins (£20,220 per mile) (this

figure applies to the Batavia tramways) and 25,000 florins (£3,350 per mile), the mean being 30,000 florins (£4,020 per mile).

The working expenses are lower than in the case of the main-line railways, but the undertakings by no means all show favourable results.

X. — NORWEGIAN STATE RAILWAY.

The Norwegian State informs us that there are in Norway nine light railways, total length 342 kilometres (212 miles); 110 kilometres (68 miles) of them have a gauge of 1·45 metres (4 ft. 9 in.), and the rest have narrow gauges of various sizes.

The State generally contributes half the capital. Of this half, 50 per cent is payable outright, and the other 50 per cent is in the form of shares.

The lines are operated by concessionaries. The concessions are granted by royal order after approval by the Storthing.

The average cost of the standard-gauge lines was 43,000 kroner per kilometre (£3,875 per mile). The cost of the narrow-gauge lines varied between 27,000 and 40,000 kroner per kilometre (between £2,430 and £3,600 per mile).

In 1907, the receipts varied between 1,198 and 2,600 kroner per kilometre (between £107.19*s.* and £214 per mile), and the working coefficient between 112 and 68 per cent.

The coefficient 112 per cent corresponded to receipts of 2,113 kroner (£169.6*s.* per mile) in the case of line 21 kilometres (13 miles) long and having a gauge of 1·067 metres (3 ft. 6 in.).

The coefficient 68 per cent corresponded to receipts of 1,940 kroner (£155.8*s.* per mile) in the case of a line 26 kilometres (16 miles) long and having a gauge of 0·75 metre (2 ft. 5 $^1/_2$ in.).

XI. — HOLLAND.

Dutch Railway Company.

The Dutch Railway Company operates about 400 kilometres (248 miles) of light railway which it leases from the concessionary companies.

All these lines, which have a gauge of 1·45 metre (4 ft. 9 in.), are operated jointly with the corresponding main lines. The expenses are included in the general expenses of the system. A separate account is kept of the receipts.

Without entering into detail about the leasing contracts, the company states that the result is satisfactory to both parties concerned.

It considers that the essential clauses of the leasing contract are :

1° As regards the track and the stations : the approval of the plans and the general supervision of the future operator during the construction; a double examination of the works at the beginning of the operation and two years after;

2° As regards the rolling stock : the approval of the plans by the operator, unless he provides it himself;

3° As regards the operation : the operator must be interested in the development of the traffic.

Company operating the Dutch State Railway.

This company leases 172 kilometres (107 miles) of light railway. It states that the results are satisfactory, and that the clauses desirable vary in the case of each line and each district.

XII. — PORTUGAL.

Portuguese National Railway Company.

The Portuguese National Railway Company operates two 1-metre (3 ft. 3 3/8 in.) gauge lines, one 55 kilometres (34 miles) long and the other 80 kilometres (50 miles) long. It has a guarantee of 4·5 per cent on the cost of construction per kilometre, fixed by agreement. The working expenses are taken equal to 50 per cent of the gross receipts, with a minimum of 3,900 francs (£251 per mile) and a maximum of 6,600 francs (£425 per mile). Any surplus or net receipts are divided equally between the State and the concessionary. The actual working expenses are 2,800 francs (£180 per mile); as the minimum expenses are fixed by the concession at 3,900 francs (£251 per mile), there is a profit of 1,100 francs per kilometre (£71 per mile).

The company observes that it is to the advantage of the concessionaries to keep the receipts near the minimum fixed for the expenses, and this might be a disadvantage to the public; it states however that in Portugal, fortunately, concessionaries are not tempted to abuse their contracts.

XIII. — RUSSIA, BRITISH COLONIES, UNITED STATES OF AMERICA.

The few answers received from Russia, the British Colonies und the United States do not give us any information of interest concerning the question under consideration.

This is apparent from the information given in the first part of our report.

XIV. — SWITZERLAND.

The Swiss light railways have not supplied us with any information.

The figures for 1907 and 1908 are :

—	Length, in kilometres (in miles).		Receipts, in millions of francs.	
	1907.	1908.	1907.	1908.
Standard gauge	694 (431)	744 (462)	11·200 (£448,000)	11·500 (£460,000)
Narrow gauge	872 (542)	917 (570)	12·178 (£487,120)	12·975 (£519,000)
Rack railways	39 (24·2)	39 (24·2)	1·597 (£63,880)	1·543 (£61,720)
Tramways	365 (227)	377 (234)	11·739 (£469,560)	12·475 (£499,000)
Cable railways	18 (11·2)	18 (11·2)	1·205 (£48,200)	1·288 (£51,520)

This information is taken from the *Feuille du Commerce*. It is of course evident that rack and cable railways are in no way light railways.

The mean receipts per kilometre (per mile) were 15,460 francs (£995.4*s*.) for the standard-gauge lines, 14,120 francs (£908.19*s*.) for the narrow-gauge lines, 39,568 francs (£2,547.2*s*.) for the rack railways, 72,528 francs (£4,668.16*s*.) for the cable railways and 33,110 francs (£2,131.8*s*.) for the tramways.

CONCLUSIONS.

Under the laws existing in each country, light railways have taken and are every day taking a greater development in all the countries where there is a main-line system forming a close network. England and the United States are however exceptions. The situation is not materially different from that expounded in 1905 by Messrs. Colson and Ziffer.

It is difficult to answer question XVIII such as it has been formulated by the Congress, and to give the results of the different systems enumerated in operating light railways.

Many administrations have sent no information. More especially have we received no answer from Prussia and Germany; here we can only record that the operation is by private enterprise. In France, the authors of the answers sent to us have not given any definite answer. We have only received really clear and concise answers from Belgium, Austria and Hungary. The formula of the *Société Nationale des chemins de fer vicinaux*, which has produced such happy results in Belgium, is so

well known that it is unnecessary for us to draw attention to it. In Austria and in Hungary, we have operation by the State. In Hungary, the Minister informs us definitely that working by the State involves a loss of 10 million kronen (£416,000); and this is the subvention necessary for establishing the light railways.

Under these conditions, we will not undertake to draw up any conclusions. At most we will allow ourselves to formulate a personal appreciation.

Everything concerning concessions was expounded by Mr. Colson to the 1905 Congress, and has been repeated in the preamble and the annexes of the bill concerning light railways brought before the Chamber of Deputies of France. Mr. Colson expounded, with his great authority, how important it is to pay attention to the factor train-kilometres, so as to induce the operator to develop traffic. But once this has been said, nobody ventures to state what the result of the formulae in use is, or to lay down other complete ones.

To us, this is a consequence of the economic transformation which results, in every country, from the new social conditions.

It is necessary that the formula of operation should allow the operator to live; it is at present very difficult to find a satisfactory one, as expenses are continually growing. We are not far from thinking that the solution to be preferred is that of contract working as described by an Austrian company.

APPENDIX.

Detailed list of questions relating to question XVIII.

I. — Leasing.

1. Do you operate lines leased by you? If so, mention their length and gauge. Can your rolling stock be interchanged with other lines? State whether your railway system consists solely of leased lines.

2. Are your lines leased by concessionary companies or by collective bodies such as the State, a department, province or commune?

3. Is the sole object of your company the operation of leased lines?

4. Have you been concerned in any way with the construction of the lines and the supply of their rolling stock? Were the plans submitted to you before construction? Had you any share in the construction, as regards for instance the roadbed and the building of the stations? Did you afford financial assistance towards the construction? In what circumstances can you demand an increase in the rolling stock?

5. For what period does your contract last?

6. State as fully as possible what results have been obtained? Mention the advantages and disadvantages of the regime, both as regards the public and the two contracting parties.

7. What are in your opinion the essential clauses to be introduced into a leasing agreement to ensure good operation from the standpoint of laying down the track, arranging the stations, supplying rolling stock and what is the best way of stimulating the operator to develop the traffic.

II. — Joint operation with the corresponding main railway.

1. Have you any lines operated jointly with the corresponding main railway, understanding by the term joint operation, a genuine leasing of the light line by the main line which incorporates it in its own system.

2. What are the reasons which induced you to adopt this method? Explain how the system works from the standpoint of earnings and expenses.

III. — Operation by the concessionary himself.

1. Do you operate your lines yourself? If so, state the length of the lines open? Is your line disconnected at both ends? What is the gauge? Can you interchange your rolling stock with other lines?

2. What is the working formula of your concession? Do you get a subsidy or a guarantee from the authority granting the concession? What formula is imposed upon you in calculating the guarantee? Has the authority granting the concession to take a share in the increase of the rolling stock and in the enlargements necessitated by the growth of traffic?

3. State, in the broadest manner possible, the results of your operating and the advantages and the disadvantages of the system followed to the public, the concessionary and the authority granting the concession.

4. What in your opinion is the best formula to be employed, both as regards the concession and the operation of the line, so as to stimulate the concessionary to develop the traffic?

IV. — Additional questions.

Have you any lines that you operate yourself, but for which you have received assistance from the corresponding main line, either in that it has helped you in getting your capital, or that it helps you in operation, by lending you if required rolling stock and even staff?

There might under these circumstances of operation by the concessionary, assisted by the main line, be various solutions in individual instances.

We should be most grateful if you would expound any with which you are familiar and the circumstances which gave rise to such solutions.

We would further beg you to inform us what legal enactments control your concession.

[625 .611]

SUPPLEMENT TO THE REPORT

By Mr. PLOCQ,

INGÉNIEUR CHEF DE L'EXPLOITATION
DES RÉSEAUX DE LA SOMME ET DU NORD DE LA SOCIÉTÉ GÉNÉRALE DES CHEMINS DE FER ÉCONOMIQUES FRANÇAIS.

GREECE.

The Greek North Western Railway Company has supplied us with some interesting information on the subject of railways in Greece.

There are 1,155 kilometres (718 miles) of railway in Greece, including 1,000 kilometres (620 miles) with a gauge of 1 metre (3 ft. 3 3/8 in.) and 52 kilometres (32 miles) with a gauge of 0·75 metre (2 ft. 5 1/2 in.)

Except the larger-gauge line, Piraeus-Athens-Larissa frontier, all of them can be considered as local lines.

Up to 1880, the State granted concessions with lump-sum subventions of 20,000 francs per kilometre (£1,287 per mile). The Thessaly, Piræus, Nauphies, Patras, Pyrgos lines were built in this way.

These lines and the small Laurium railway were operated by the concessionaries.

But the State, in order to accelerate the development of the railway system, decided to extend it itself and to lease the working. This resulted in the construction of the North Western lines, Missolonghi, Agrinion, which will be extended to Arta, the frontier of Epirus, and of the Central Peloponesian line, Myli, Tripolis, Kalamata, Kyparissia, which will be extended to Sparta.

As a rule, the operation of the line is at the cost, charge and risk of the operator; but losses are repaid out of the yield of subsequent years, so that it forms a sort of joint undertaking, as the company states.

In order to avoid complicated accounts and to protect itself against risks, the State as a rule adopts for the working expenses the formula

$$4{,}000 + \frac{R - 4{,}000}{2},$$

this formula includes the working expenses, the cost of maintenance of the line, and the cost of upkeep and renewal of the rolling stock. Any surplus is paid over to the State.

In several cases, the operator was also the contractor who built and equipped the line.

The Greek North Western Company considers that the system adopted is favourable both to the State and to the operator.

*

SECTIONAL DISCUSSION

Meeting held on 5 July, 1910 (morning).

MR. BEHRENS, PRESIDENT, IN THE CHAIR.

The President. (In French.) — I call upon Mr. Plocq kindly to give us a summary of the report he has drawn up about question XVIII.

Mr. Plocq, *reporter.* (In French.) — Gentlemen, to begin with I must request you to accept my apologies; I am not accustomed to public speaking, and, moreover, men more competent than I could certainly have drawn up a better report on this very delicate question.

According to the practice of the Railway Congress, I must limit myself to a very short summary of my report and then read out the conclusions. In the first place, I had to refer to the authoritative reports presented to the last session by Messrs. Colson and Ziffer, who described the state of the law in the different countries of Europe and America. I next thought it necessary to give a summary of that legislation. I added particulars about the alterations which have been made or are going to be made in the legislation of the different countries. I mentioned Spain where a complete law concerning light railways has been enacted, which seems, however, to have produced no results, as I have received no answer from that country.

In France, some years ago, a bill was brought forward by Mr. Barthou, minister of public works, modifying the act of 1880.

Mr. Colson's earlier report sets forth the situation in a very clear way and shows what modifications should in his opinion be introduced in the formulæ. He specially urges that in the working formulæ the train-kilometre should have a sufficiently great coefficient to make the operator have an interest in increasing the number of trains with a view to the development of traffic.

Some modifications have also been introduced in the Italian law; they concern the sums which can be placed every year at the disposition of the light railways.

After giving a sketch of the history of the subject, I proceeded to the subject itself. I drew up a detailed list of questions which you can find at the end of my report; they define the points about which information is desirable. Unfortunately the answers which I have received do not

always strictly apply to the questions asked.

I received very detailed information from Austria and Hungary. In each of those countries the subject is treated from a special point of view, as the State shows a growing tendency to undertake the operation of the light railways. I need hardly mention the country in which the problem of light railways is thoroughly worked out : I mean Belgium. Mr. de Burlet has explained in several reports how the Belgian National Suburban Railway Company is managed, with leases and working concesssions to private parties, to communes, etc.; but as regards the question such as set, I have found few details. Even from France where the working formulæ play such an important part as regards light railways, there have been few or no answers. It seems that leasing has given good results, but no details are given about the formulæ. From Germany, where there are many light railways, where the provinces assist in building them and where there are lessees and important firms, such as the firm Lenz, who operate a large number of railways, I received no answer; I was even given to understand that they did not wish to give answers.

Under these conditions, it is useless to lay stress on the figures which I have quoted.

To sum up, Gentlemen, I do not think I can do better than read out to you my conclusions. They run as follows :

Under the laws existing in each country, light railways have taken and are every day taking a greater development in all the countries where there is a main-line system forming a close network. England and the United States are, however, exceptions. The situation is not materially different from that expounded in 1905 by Messrs. Colson and Ziffer.

It is difficult to answer question XVIII such as it has been formulated by the Congress, and to give the results of the different systems enumerated in operating light railways.

Many administrations have sent no information. More especially have we received no answer from Prussia and Germany; here we can only record that the operation is by private enterprise. In France, the authors of the answers sent to us have not given any definite answer. We have only received really clear and concise answers from Belgium, Austria and Hungary. The formula of the *Société nationale des chemins de fer vicinaux*, which has produced such happy results in Belgium, is so well known that it is unnecessary for us to draw attention to it. In Austria and in Hungary, we have operation by the State. In Hungary, the Minister informs us definitely that working by the State involves a loss of 10 million kronen (£416,000); and this is the subvention necessary for establishing the light railways.

Under these conditions, we will not undertake to draw up any conclusions. At most we will allow ourselves to formulate a personal appreciation.

Everything concerning concessions was expounded by Mr. Colson to the 1905 Congress, and has been repeated in the preamble and the annexes of the bill concerning light railways brought before the Chamber of Deputies of France. Mr. Colson expounded, with his great authority, how important it is to pay attention to the factor train-kilometres, so as to induce the operator to develop traffic But once this has been said, nobody ventures to state what the result of the formulæ in use is, or to lay down other complete ones.

To us, this is a consequence of the economic transformation which results, in every country, from the new social conditions.

It is necessary that the formula of operation should allow the operator to live; it is at present very difficult to find a satisfactory one, as expenses are continually growing. We are not far from thinking that the solution to be preferred is that of contract working as described by an Austrian company.

Mr. Campiglio, *vice-president*. (In French.) — I will supplement, as regards Italy, the information given by Mr. Plocq.

In Italy, an act of later date than that mentioned by Mr. Plocq has raised the subventions for seventy-year concessions to 8,000 lire (£515 per mile) and for fifty-year concessions to 9,100 lire (£586 per mile).

If in spite of this capitalists, and especially those who are learned in railway matters, have kept aloof, this is because the contracts provide that the government takes too great a share of the gross receipts starting from a certain limit, which is fixed in the contracts in each individual case.

This share generally varies between 30 and 35 per cent.

Moreover, another article of the act settles that the State participates in the net profits, its share being generally 50 per cent of the net profits exceeding 5 per cent on the capital. It follows that as soon as the share of the gross receipts begins to become due, the operator, instead of benefiting by the growth of the traffic, loses money, and the more the traffic grows, the greater his loss, as the working coefficient of lines with little traffic amounts to about 90 per cent in Italy.

The Italian Railway Union had clearly foreseen what has happened, and when the bill was published it drew attention to the serious consequences which would result. But the ministry and the parliament considered the protests as made purely in the interests of the concessionary railway companies, and having but a mediocre knowledge on the subject, they did not even succeed in grasping the evident meaning of some examples which had been worked out in order to make the matter clear. Moreover, several concessions had previously been accepted by the delegates of provinces (not less ignorant of such matters), and this fact seemed to the government the best proof that the protests were not justified.

Now events very quickly began to show that the protests were well-founded. The province of Bergamo, which holds the concession for the electrified railway line in the valley of Brembana, has already found itself in a very critical position, because its traffic has increased enormously and has exceeded the limit at which the operator begins to have to pay over to the government part of the gross receipts.

The same applies in Italy to the tramways. The old act provided for a subvention of 2,000 francs per kilometre (£128 per mile). But here again the same condition comes into play: as soon as the receipts exceed a certain limit, the concessionaries must pay 30 to 40 per cent of the gross receipts to the government. Consequently, as the average working coefficient of the tramways is 75 per cent, as soon as the limit is attained the concessionaries have no further interest in developing the traffic.

Something might also be said about certain other conditions which prevent suburban lines and tramways from being worked more economically, but that

would necessitate going into too many details.

Mr. Machowetz, Austrian State Railway. (In German.) — I will allow myself to refer briefly to the financial subvention granted in 1908 to the local lines by the administration of the Austrian State Railway. It seems to me necessary to give this information in order to make it possible to draw a conclusion as to the magnitude of the local railways in Austria and as to the extent of the financial subventions given by the State.

In 1908, there were one hundred and eighteen local lines operated by the State, having a total length of about 4,400 kilometres (2,734 miles). Of this, about 1,900 kilometres (1,180 miles) belong to local lines enjoying State guarantees, that is to say, to which the State guarantee the interest on the preference capital.

The President. (In German.) — Those figures are in the report.

Mr. Machowetz. (In German.) — No sir, they are not there.

The President. (In German.) — Excuse me, you will find them in the report on page 15.

Mr. Plocq, *reporter*. (In French.) — The honourable gentleman states that the figures given in my report refer to the end of the financial year 1907, while the figures he is giving refer to the end of 1908.

Mr. Machowetz. (In German.) — Thus out of this whole length, 1,900 kilometres (1,180 miles) (about 41 per cent) of the local lines are lines guaranteed by the State, and in fact the State paid to these local lines in 1908, on account of these guarantees, the sum of 5,700,000 kronen (£237,120). Moreover, the State has taken over to its own account about 600,000 kronen (£24,960) for operating local lines which are operated by contract or which have a clause for postponement of working expenses, so that in 1908 the State contributed altogether 6,300,000 kronen (£262,080).

Out of the one hundred and eighteen local railway companies, seventeen gave very good results and the return on the capital invested generally reached 4 per cent or came very near this. Only seven showed a deficit, with receipts lower than working expenses. In 1908, the coefficient of working of all the light railways operated by the State was 56 per cent. But in 1909, it rose to 60 per cent owing to the increases in pay and in the price of materials.

The President. (In German.) — You have only spoken about twenty four companies; how are matters with the other ninety four?

Mr. Machowetz. (In German.) — The results vary. Some are good, others less good, etc. I have only mentioned the best and the worst. In the conclusions relating to question XVIII, it will be remembered that Mr. Colson proposed in 1905 that in the agreements relating to concessions the number of train-kilometres should be taken as an important factor in the working results. Now I do not quite see what this means. Is it a question of foreseeing a given number of train-kilometres or else of fixing the limit of the expenses according to the

number of train-kilometres? The conclusions only give me imperfect information about this point. The reporter says :

" Mr. Colson expounded, with his great authority, how important it is to pay attention to the factor train-kilometres, so as to induce the operator to develop traffic. But once this has been said, nobody ventures to state what the result of the formulæ in use is, or to lay down other complete ones."

I do not quite understand that phrase. Is it necessary to fix in the working formulæ the annual mileage expected, in train-kilometres, or else fix a unit rate per train-kilometre as limit of the working expenses?

The President. (In French.) — Can you explain this, Mr. Plocq?

Mr. Plocq. (In French.) — I think that the honourable member means that part of my conclusions which refers to what was said by Mr. Colson at the 1905 Congress; but I do not exactly understand his question.

This is how matters stand : when a concession for a railway is granted to somebody and the latter receives a guarantee from the State, the departments or the provinces, one says to that concessionary, you must calculate your expenses according to a given formula; now the first formula was :

k (*k* being a fixed amount) plus a fraction of the receipts.

For instance, the concessionary was told : you shall be entitled to 2,000 francs (£128 per mile) plus three-tenths of the receipts. If the latter amounted to 3,000 francs (£193 per mile), the concessionary was entitled to the constant 2,000 francs (£128 per mile) plus three-tenths of the receipts, that is to 2,900 francs (£186 per mile) altogether.

The act of concession stated that the concessionary must run, for instance, three trains per day in each direction. It is evident that if the traffic grew to such an extent that the goods traffic could not be carried by the existing trains, it was necessary to run additional trains.

Now as soon as the concessionary increases the number of trains, he incurs an expenditure which increases at once, but for which no allowance is made in the formula. Mr. Colson stated that under these conditions a factor should be introduced to allow for the train-mileage. I will explain. If for instance, the formula says three trains in each direction, over a length of 1 kilometre (0·62 mile), that gives 6 train-kilometres (3·7 train-miles). If another is added in each direction, that gives 8 train-kilometres (5 train-miles) per day. Well, what Mr. Colson says is this : in the formula, insert a term representing the number of train-kilometres multiplied by a certain coefficient, so that if one train more is required per kilometre, one has a sum of 30, 40, 50, 60 or 70 centimes (4·63, 6·18, 7·72, 9·27 or 10·81 pence per mile), for instance. It is for the concessionary to settle with the grantor the fixed sum he is to receive, plus the percentage of the receipts, and finally the amount he is to receive per extra train-kilometre. The grantor in fact says to the concessionary : if you put on more trains, I will pay you for them according to the conditions agreed.

Mr. Machowetz. (In German.) — In other words, the fixed amount, the constant if you like, never varies, even when the mileage is greater?

Mr. von Ziffer, *vice-president.* (In German.) — No, there will be an extra amount for the mileage beyond the fixed limit.

Mr. Francis Level, Anvin-Calais Railway, France. (In French.) — Mr. Colson was struck in his investigations by the fact that the two-term formula in certain cases led to a conflict of interest between the grantors and the concessionaries; that is why he tried to discover another formula. It must, however, be noted that Mr. Colson has not confined his attention to formulæ of two and three terms; he has also investigated the four-term formula, which includes a ton-mileage term. The grantor and the concessionary must try to come to an agreement as to which formula is the best to apply in any individual case, so that the interests of both parties and the interests of the public should always, as far as possible, point in the same direction.

Mr. de Burlet, *vice-president.* (InFrench.) — All that is very complicated. I think that we in Belgium have formulæ which are both simple and rational.

Mr. Machowetz. (In German.) — I think that in such theoretical matters, formulæ do not go very far; that is only the case in France.

I also wish to say a word about the question of leasing light railways, with a share of the net profits. I think it is difficult to establish any general rule and that every local line must be considered by itself. Other methods of calculation can also be found, for instance, by totalizing the mileage or by taking the percentage of receipts. But it is difficult to establish a general rule.

In conclusion, I may mention that a new law concerning the local railways of Austria is now being worked out, but as it is not yet settled I am unable to give details.

Mr. de Burlet. (In French.) — Has the draft of this law been published?

The President. (In French.) — No.

Mr. von Ziffer. (In German.) — The two chambers of the Reichsrat have recently passed a new act concerning secondary railways, coming into force 8 August 1910. It contains some improvements on the old act of 31 December 1894 and must hence be considered a step in advance; but it only takes into consideration to a slight extent the proposals submitted by the Austrian Union of local railways and by the Association for promoting local lines and tramways, proposals which had the object of inducing capitalists and savings banks to interest themselves more in undertakings of this kind. In this act the fiscal point of view plays a preponderating part. I may add that also in Rumania has a new act been passed. This enacts that all standard-gauge lines intended for the public service shall receive a subvention of 1,500 francs per kilometre (£96 per mile) for thirty consecutive years, no matter what the yield of the lines may be; moreover, the land belonging to the State is given free of charge, and finally, the act grants important facilities in construction and operation.

Colonel Suarez, Ministry of public works, Bolivia. — There are 1,128 kilometres (700 miles) of local railways in the State of Bolivia. These railways date back to 1892. The results are really marvellous; dividends of 17·5 per cent are paid.

The concession was granted in 1892 by the Bolivian government to an English company, the State giving a guarantee of 6 per cent. This guarantee has never been called upon because, as I have already stated, the results have been very excellent. This railway goes up to a height of 14,000 feet. The country is very mountainous. This line is not of metre (3 ft. 3 3/8 in.) gauge like the other railways, but it will be so in a few years. The shares now stand at double their original value.

Mr. Losseff, Home Railway Union of Russia. (In French.) — What are the steepest gradients and the sharpest curves?

Colonel Suarez. — At the moment I cannot tell you what gradients and curves there are, but I can give you that information later on.

Mr. de Burlet. (In French.) — Are those lines operated by the concessionaries themselves?

The President. (In French.) — Yes.

Mr. Bello, Portuguese National Railway Company. (In French.) — I place on the table a note about the narrow-gauge lines in Portugal. If you like, I will read it.

The President. (In French.) — Certainly.

Mr. Bello, (In French.) — This is the note in question :

In Portugal, 1 May 1910, there were 450 kilometres (280 miles) of narrow-gauge lines in operation :

State :			
Line from Livracão to Amarante (1 metre [3 ft. 3 3/8 in.] gauge).	13 kilometres	(8 miles).	
Line from Regoa to Vidago (1 metre [3 ft. 3 3/8 in.] gauge).	77 —	(48 —).	
			90 kilometres (56 miles).
National Railway Company :			
Line from Tua to Braganza (1 metre [3 ft. 3 3/8 in.] gauge).	135 kilometres	(84 miles).	
Line from St. Comba Dão to Vizeu (1 metre [3 ft. 3 3/8 in.] gauge).	50 —	(31 —).	
			185 kilometres (115 miles).
Guimaraes Railway :			
Line from Trofa to Fafe (1 metre [3 ft. 3 3/8 in.] gauge) . . .	...		56 kilometres (35 miles).
To carry forward. . .	...		331 kilometres (206 miles).

Brought forward. . .	...	331 kilometres (206 miles).
Oporto, Povoa and Famalicão Railway :		
Line from Oporto to Famalicão (gauge 0·90 metre [2 ft. 11 1/2 in.])	58 kilometres (36 miles).	
Line from Oporto to Leça (gauge 0·90 metre [2 ft. 11 1/2 in.]). .	6 — (4 —).	
		64 kilometres (40 miles).
Vouga Valley Railway :		
Line from Espinho to Albergaria-a-Velha (1 metre [3 ft. 3 3/8 in.] gauge)	...	55 kilometres (34 miles).
Total. . .	...	450 kilometres (280 miles).

The lines from Oporto to Povoa and to Famalicão have a gauge of 0·9 metre (2 ft. 11 1/2 in.); all the others are metre (3 ft. 3 3/8 in.) gauge.

The cost of construction of these lines averaged 100,000 francs per kilometre (£6,437 per mile).

At the end of 1907, altogether 336 kilometres (209 miles) were in operation, 43 (27 miles) of which belonged to the State and 293 (182 miles) to companies.

The receipts and expenses per kilometre in 1907 were :

Traffic receipts	471,718,272 reis (£104,826.5*s.* 7·9*d.*);
Per kilometre (per mile).	1,403,925 — (£502.1*s.* 6·86*d.*);
Expenses	277,759,192 — (£61,724.5*s.* 3·6*d.*);
Per kilometre (per mile).	826 664 — (£295.12*s.* 8·7*d.*).

The working coefficient averaged 58·88 per cent.

These lines carried :

Passengers.	1,465,914.
Quick-freight goods.	10,194 tons (10,032 English tons).
Slow-freight goods	219,286 — (215,822 — —).

Mr. de Burlet. (In French.) — Is the cost of rolling stock included in the cost of construction you have named?

Mr. Bello. (In French.) — Yes, everything is included. It is a question of total outlay per kilometre. This, I repeat, averaged 100,000 francs per kilometre (£6,437 per mile), rolling stock included.

Mr. de Souza, Portuguese State Railway. (In French.) — Here is some information about the light railways of my country. They help to confirm the conclusions in Mr. Plocq's excellent report.

I am going to show you the difficulty of arriving at a sufficiently flexible formula for facilitating the development of light railways.

At first concessions were granted without any subvention.

Two companies are exceptionally placed and one even pays a dividend of 6 per cent. One is a suburban line; the other has a very large traffic in a distant district where there is a considerable population. Accordingly, these cannot be taken as typical.

In smaller places where there are few inhabitants, the assistance of the government is absolutely necessary.

Concessions have been granted for nearly 180 kilometres (112 miles) of lines which are in operation; but with the existing formula, the greater the traffic the greater the loss.

That is why attempts are being made to arrive at another formula.

In the first place, as it was a question of a rather mountainous country where there is a broad-gauge main line which ought to have several feeders of metre (3 ft. 3 3/8 in.) gauge, a given share was granted, and exemption from tax, custom duties, etc., was also granted; but as there was no fixed guarantee, this formula did not give encouraging results.

There is only one short section forming an extension of a line already constructed, which was built under these conditions.

Some time later, another plan was adopted : a guarantee of 5 per cent on a capital of 5,000 francs for the construction was given; but the guarantee of the government never exceeds 3 per cent.

One of the lines found great difficulty in raising the capital, but it is on the eve of success.

As the State operates lines running through an important and very undulating district, and as a broad-gauge line would be too expensive, the metre (3 ft. 3 3/8 in.) gauge has been adopted for the feeder lines.

The State is at present building several lines and has fixed rather flexible conditions; but one is too much affected by the proximity of the broad-gauge line.

In short, construction and operation are expensive.

In the districts where it is difficult to raise capital for building light railways, it would be preferable to grant a reasonable percentage and to fix a well thought-out formula for the operation.

It is necessary to make it to the interest of the operator to increase his receipts.

We have nearly 450 kilometres (280 miles) in operation, the formulæ varying widely, and we are still undecided as to the best way of developing these lines.

As for tramways, we hardly have any. An act has been passed to promote their construction; but no subvention is given, only the permission to utilize the highways, and that only under condition of maintaining them.

Taking it altogether, this act has not produced any good results.

Mr. Waechter, Vering & Waechter Company, Germany. (In German.) — I wish to explain why Germany sent the Congress so little information about the subject of light railways. It is due to the fact that none of the companies operating such lines belong to the Congress. My company also has nothing to do, except incidentally, with what we call minor railways.

I may add that the adoption of a special indemnity per train kilometre covered has given good results in Germany, particu-

larly if with increasing gross receipts there is a decreasing scale for the working expenses.

Mr. Plocq, *reporter*. (In French.) — I knew quite well that the German private companies operating the light railways did not belong to the Congress; accordingly I tried to obtain information by applying to those companies direct, but they preferred to keep reserved.

Mr. Van Nierop, Dutch Tramways. (In French.) — All those companies which publish reports are joint-stock companies, are they not?

The President. (In German.) — Do these reports exist?

Mr. Waechter. (In German.) — They are published in certain papers (1).

Mr. de Burlet. (In French.) — But the reports and balance-sheeets of such joint-stock companies do not as a rule contain much information from the technical point of view; they give hardly anything except financial information. Anyone who wanted, on the basis of these reports only, to obtain information about technical questions and leasing contracts, would be very badly informed.

Mr. Van Nierop. (In French.) — But that is what we are considering.

Mr. de Burlet. (In French.) — I beg your pardon; we are considering working formulæ and not financial questions, which are the sole object of the reports of private companies.

Mr. Van Nierop. (In French.) — If there are any subventions, they appear in the reports.

Mr. de Burlet. (In French.) — I repeat that if only those documents were available, that would be a very difficult investigation for anybody undertaking it.

Mr. Donker Duyvis, Semarang-Cheribon Tramways, Dutch Indies. (In German.) — At page 24 of his report (1), Mr. Plocq states that the working expenses of the light railways in Java are lower than in the case of main-line railways, but that these undertakings are far from all showing good results. However I know some to which this does not apply. Accordingly I am able to state that the great majority of these lines give very good results, and so prevent Mr. Plocq's words from giving a wrong impression.

I am manager of the four companies mentioned on page 9 (2). It is said that these four important companies, although quite distinct, have a joint management.

I had no intention of taking part in this discussion, but I wish to state that in 1909 these four companies paid dividends of 10, 9, 9 and 5 per cent respectively.

Of the eleven companies mentioned (the chief are in Java), there are only three or four which pay no dividend, but the others pay very fair dividends.

These results are due not only to the

(1) *Zeitschrift für Kleinbahnen*, edited by the Ministry of public works, published by J. Springer, Berlin.

(1) See also *Bulletin of the Railway Congress*, October 1909, p. 1286.

(2) See also *Bulletin of the Railway Congress*, October 1909, p. 1271.

energy of the operators, but also to the legislative provisions issued in 1893 by the government of the Dutch Indies, which are mentioned by Mr. Plocq in his report and which have made possible the extensive development of the light railways, to the great advantage of the country generally.

Mr. Plocq himself states that in 1895 there were nearly 2,000 kilometres (1,240 miles) of light railways in existence, while there were far fewer before more liberal regulations had been issued by the Dutch government.

It is hence only just to correct, as regards the Dutch colonial government, the conclusions of Mr. Plocq's report.

Mr. Plocq. (In French.) — I certainly did not intend to make criticisms and to say that the lines on the island of Java do not give good results; but I have recorded that a certain number exist which do not pay. The chief lines which form a large jointly-operated system pay; that is the truth.

The Batavia tramways are magnificent lines, but there are some which do not pay (1). Thus I did not want to make any criticisms whatever.

Very interesting information has been sent to me : a splendid album with views of your lines, and I was particularly struck by the fact that these lines, although quite distinct, had one and the same management and that the employees were bound to serve sometimes on one line, sometimes on another. That is a notion which we eventually propose to turn to our advantage. (*Laughter.*)

I have a small communication to make. After my report had been printed, that is to say after April, there was sent to the Permanent Commission, at Brussels, a very complete report, not from the point of view of the results of working, but from the point of view of the position of the Greek railways. I have made a summary of it which has been published as a supplement to my report (1).

Mr. de Burlet. (In French.) — Mr. Plocq, in his report, has given a flattering notice about the organization of light railways in Belgium, for which I thank him. He refers his readers to the reports which have already been published about the Belgian system, but as several of our colleagues who are here have perhaps not had any opportunity of reading those reports, I ask your permission, in order to meet the wishes of the President, to give you a brief account of the principles on which the organization of local lines in our country is based.

Belgium is, as regards iron roads, really in a privileged position. At the present time we have in Belgium, in our small country, 4,600 kilometres (2,858 miles) of main railroads, that is to say, of railways of general interest. This represents 15·5 kilometres per 100 square kilometres (24·9 miles per 100 square miles). England, per 100 square kilometres (per

(1) Note by Mr. Donker Duyvis : there are two at Batavia. One is an electric line which does not pay at all; the other is a steam line (locomotives without fire-box) which gives good financial results, paying 9 per cent in the last financial year for which a report is published.

(1) See *Bulletin of the Railway Congress*, June 1910 (1st part), p. 2707.

100 square miles), has 11·5 kilometres (18·5 miles) of railways, Germany 10 (16·1 miles) and France 8·5 (12·9 miles). Most of the main railroads in our country are operated by the State, the State having bought up nearly all the lines for which concessions had been granted; it has also built others itself. Thus at present out of the total 4,600 kilometres (2,858 miles) of main railroads, only 360 kilometres (224 miles) are still operated by private companies.

As regards railways of local interest or light railways, which we call in Belgium suburban railways, they are under quite special laws.

In 1885 an act was passed creating a central administration charged with everything affecting light railways in our country. This is the Belgian National Suburban Company. It has a monopoly; that is to say if any private parties ask for a concession for a light railway, the company has the preference for a year. If during that time the company has not asked for a concession for that line, the government can grant it to those private parties.

But what is of great interest in our organization and what in my opinion has been the cause of its success, what has enabled it to develop so extensively in a short time, is the way in which the capital required for the construction of the line is raised, with the intervention of the State, the provinces and the communes, by means of the issue of shares. These three great organizations exist in nearly all countries in Europe : the central authority, the provinces (called departments in France) and the municipalities. The capital is thus provided by these three sets of public authorities, eventually with the assistance of private parties. The State finds half; it is not compelled to do so by law, but has itself fixed this amount at 50 per cent, and it cannot legally go beyond this. The provinces and the municipalities subscribe the rest of the capital.

The President. (In French.) — In equal shares?

Mr. Burlet. (In French.) — No, this varies. This point is also left undetermined in the act; some provinces take one-third, others one-fourth, and the communes the remainder. If the province gives one-third, only one-sixth is left for the communes to subscribe; if the province gives one-fourth, the communes also give one-fourth.

With us there is question neither of guarantee of interest nor of lump-sum subvention. The State, the provinces and the communes subscribe for shares. I will assume a line costing a million of francs (£40,000); the State takes 500,000 francs (£20,000) worth of shares, the province 250,000 francs (£10,000) and the communes the same amount. The latter have to arrange between themselves, in accordance with principles not fixed by the act, and which could not so be fixed, as to the division of the 250,000 francs (£10,000). There is, I repeat, neither subvention nor guarantee of interest, so that once the line has been built, the three branches of the public authorities are interested, *pro rata* according to the shares they hold, in developing the traffic and in seeing that the line produces the maximum of services and receipts which one can except from it.

A delegate. (In French.) — The line?

Mr. de Burlet. (In French.) — Yes, each line forms a separate undertaking, each has its own separate accounts. A commune which is interested in a given line has nothing to do with any other line in which it does not hold shares. Thus there are as many small companies as there are lines. By agreement of the shareholders, the capitals of several small lines can be combined together in one group.

The examination of schemes, the administration, the operation of the lines, the different sets of accounts are all looked after by the National Suburban Railway Company which manages these different departments. The development of the new system was very rapid. I reminded you when I began, that the act which definitely organized this system bears the date of 1885, and is accordingly twenty-five years old. This is the result we have arrived at : at the present time we have concessions for 4,500 kilometres (2,796 miles) of light railways. Thus you see that although the main-railroad system is already of very close mesh, yet we have managed to insert 4,500 kilometres (2,796 miles) of light railways.

The President. (In French.) — About as much as the main railroads.

Mr. de Burlet. (In French.) — That is so, as in Belgium there are 4,600 kilometres (2,858 miles) of main railroads.

These 4,500 kilometres (2,796 miles) of light railways for which concessions have been granted are not all finished; 3,750 kilometres (2,330 miles) are in operation and the other 750 kilometres (466 miles) are under construction. As soon as the concession for a line has been granted, the land required is bought, the specifications are drawn up and the works are commenced.

Besides the lines for which concessions have been granted, we have at present a number of others under consideration, and in a few years, including the schemes which are now being drawn up, we shall have altogether 6,350 kilometres (3,945 miles) of light railways, a very satisfactory result for a small country such as ours!

How do we operate these light railways? Here I return at once to the question we are considering. When our existence began, we decided, after very careful consideration of the question, not to undertake by ourselves direct, the operation of these lines which are scattered over the whole country. We thought it better to give leases to private companies. We are well satisfied with this system, and are fully convinced that if we had to centralize at Brussels, in our offices, the operation of these lines, about 170 in number, each of which has its own character and its own special needs, we should have had many difficulties, and that this system would have made operation much more costly. On some lines, the passenger traffic is very important, much more important than the goods traffic; others are above all goods lines; there are tourist lines and lines to holiday resorts; there are agricultural lines, industrial lines, seaside lines connecting the watering places along our coast; each of these lines requires special management which has to be learnt on the spot and which can be better applied if the operation is left to local groups. I regret that I have no time to elucidate this point, which is one of the most interesting features of our organization.

Of the 3,750 kilometres (2,330 miles) forming 150 different lines, we have leased 3,550 kilometres (2,206 miles) to operating companies. We ourselves provisionally operate, without intermediaries, about 200 kilometres (124 miles), and that on account of special reasons.

Private companies operate a very great part of our lines; I say a very great part, because I must tell you that the suburban lines in Belgium are operated not only by private companies; the operation of certain lines has been intrusted to a communal group. Certain municipalities which provided some of the capital have asked for the right of combining between themselves, and also, in certain cases, with the province, in order to undertake the operation of lines. At present, there are about 500 kilometres (310 miles) the operation of which is entrusted to communal groups. This is what we have called the *Société intercommunale* (intercommunal company) or the *Société intercommunale provinciale* (provincial intercommunal company); for, as I have already said, there are groups in which the province, which also provided some of the capital, also wished to be interested. It follows that on certain lines the operation is carried out by the company formed by the province and the communes. It is to this small company, which has such a special constitution, that the National Company has entrusted the operation of lines, under certain well-defined conditions.

Thus the proprietors of half the capital, as the State does not concern itself with the operation (it has decided up to the present not to participate in the operation of the suburban lines), it is I say these proprietors of half or a quarter of the capital, who in this intercommunal company, with or without the help of the province, which does not everywhere participate in this organization, it is the communal groups or the provincial communal groups which have undertaken the operation of a certain number of lines.

We also have in Belgium some lines operated by companies holding main-railroad concessions. (In Belgium, there are still about 360 kilometres [224 miles] of main railroad belonging to private companies, the rest being operated by the State.)

The Belgian Northern Railway in particular, an offshoot of the French Northern Railway, has to our great satisfaction undertaken the operation of a group of about 250 kilometres (155 miles) of suburban railways which connect with the main railroad. Gentlemen, you know the Belgian Northern well enough to know that when we entrusted the operation of the suburban lines to such an experienced, trustworthy and capable body, we could be certain of its being in very good hands.

Accordingly this is our system: we plan and we build the lines, we supply them with stock and we lease the operation to private or to intercommunal companies.

Gentlemen, I do not wish to begin the examination of a question which is not on the agenda and which, moreover, has already been thoroughly discussed at other sessions of the Congress; I mean the working formula we have adopted. It would occupy several meetings to examine and discuss this subject. We have naturally changed about a little, felt our way at the start, and did not straightway find

the best formula. I have often had the opportunity of discussing this question with one of our French colleagues, Mr. Colson, whose great authority and incontestable knowledge of this subject has frequently been appealed to, and with justice, and I think that I agree with him when I state that the formula we are at present applying in Belgium quite satisfies the desiderata which have frequently been enunciated. We wish the operator to be interested in the growth of the receipts. The arrangement must not be such that at a given moment the operator can say to himself : " It is to my interest that the railway receipts should not increase any more. " Such a condition would be absurd and against the general interest. A formula which would entail such a condition would be condemned without need of appeal. But I cannot go into details about this question of the working formula to adopt in the leasing contract and I return to the general organization of the Belgian suburban railways.

Certainly we felt our way, and changed about a little, before we succeeded in putting on its legs the system now existing, and which we think is quite satisfactory. It has stood all tests, and having ascertained what has happened in other countries, I think I may declare, without any endue criticism, that the Belgian system, of associating the three different sets of public authorities in order to develop light railways, is really practical and prolific. .

We were told a little time ago of what has happened in Portugal : at first concessions were granted for lines without any intervention of the public authorities. What happened? Why, only two lines were constructed. It is easy to foresee that with such a system of leaving the construction of light railways wholly to private undertakings, only very remunerative lines will be built, yielding high dividends, 6 per cent or more.

After these two lines had been built, which were as we are told, under exceptional circumstances, there was a standstill in Portugal. Private enterprise did nothing more and it was necessary to obtain the intervention of the State. This took several forms : lump-sum subventions, guarantee of a minimum rate of interest on the capital outlay, guarantee of a minimum for the working expenses.

I am opposed to these lump-sum subventions (I have stated my reasons elsewhere), and especially to the guarantees of minima, which have great disadvantages.

I have no time to set forth my arguments about this subject. I will merely remind you that France has had some very unpleasant experiences in this way. I have had interviews with very competent French engineers to discuss this point, interviews which have been very instructive to me. Besides, there are the results :

That I am opposed to a guarantee of interest on the capital outlay, and also to a guarantee of a minimum for working expenses, is above all, because this formula tempts the builder of the line unduly to inflate the capital outlay, and the operator of the line to inflate, also unduly, the working expenses, and because such a system compels the authority granting the concession for the line to undertake many checking and controlling operations, of a complicated, difficult and disagreeable

character, which can only result in numerous disputes.

In my opinion, of all these systems the best is intervention, in the shape of subscribing for shares.

Gentlemen, it is always a delicate matter to praise matters in one's own home and to seem to say : " *Prenez mon ours* " (1). (*Laughter.*) But I think that I may assert that our Belgian system has proved its merits and that I can with every confidence, recommend it to those who are still seeking the best formula for developing light railway systems, which have so aptly been called the brooks which must feed the rivers, in other words bring to the main railroads new elements of prosperity and of traffic. (*Prolonged cheers.*)

Mr. von Ziffer. (In German.) — I wish to point out a mistake in the report. It concerns Rumania.

The act of 1898 was superseded by a new act passed, if I am not mistaken, in 1907. This act has the object of facilitating the construction and operation of light railways in Rumania. The act mentioned by the reporter did not result in helping the construction of a single light railway in Rumania. That is why parliament passed a new act. According to this, every concessionary building a standard-gauge local railway receives a subvention of 1,500 francs per kilometre (£97 per mile) during thirty consecutive years, no matter what the net profit of the railway may be; moreover, there are a certain number of working facilities, and land belonging to the State is given free of charge. I think that I must give you this information because it is extremely interesting to know that a country gives such financial assistance to help the development of light railways. The act has already had as result the building of several local lines. I myself have worked out the scheme for one of these light railways, 76 kilometres (47 miles) in length. A company was formed which by virtue of that act receives a subvention, and the railway has now been in operation for a year. This is quite an exceptional case. In fact I do not understand why, independently of any net profits or even of high profits of a line — which may distribute dividends of 6 to 8 per cent, the company should receive, during thirty consecutive years, this subvention of 1,500 francs per kilometre.

Mr. de Burlet. (In French.) — I omitted to give you some figures which will perhaps interest you, as supplementary to the particulars I gave. We have at present invested in light railway enterprises a capital of over 303 million francs (£12,120,000). The net revenue, the mean dividend of the last few years, has been 3 per cent; this is the interest received by the State, the provinces and the communes in their capacity of shareholders.

If we have good lines, we also have mediocre ones from the point of view of the receipts, for certain parts of Belgium have no great population, nor much industry nor commerce. These are in particular the hilly districts and those where the soil is not very fertile. But what I can assert is, that all the lines render the

(1) Literally " take my bear ". A quotation from a vaudeville by Scribe and Saintine. A somewhat equivalent English phrase would be " buy my white elephant ". (*Note by translator.*)

public very great services and that the administrations do not regret the slight sacrifices they have had to make in order to ensure the building of these iron roads. Two figures to finish up with :

In 1909, we carried 75 million passengers and 5 millions tons of goods (500,000 wagons of 10 tons each).

Mr. von Ziffer. (In German.) — I congratulate Mr. de Burlet on the brilliant results obtained by the Belgian National Suburban Railway Company. I am in favour of the system of leasing based on formulæ fixed by joint agreement with the operator and varying according to local conditions, while as far as possible safeguarding the interests of the owners and of the operators of the railway. The leasing system adopted by the Belgian National Suburban Railway Company seems to me worth imitation.

Mr. Van Nierop. (In French.) — The dividend is not the same on all the lines?

Mr. de Burlet. (In French.) — No, I have given the average dividend; each line has its own capital and keeps separate accounts.

Mr. Van Nierop. (In French.) — Are there then as many sets of accounts as lines?

Mr. de Burlet. (In French.) — Yes, each line has its own accounts. If our last year's report interests Mr. Van Nierop, I shall be very pleased to let him have it and he will be able to find in it the practical and detailed application of the rules of which I have only indicated the general principles.

Contrary to what is the practice of purely private companies we strive — as we are more a public administration than a purely speculative company — to include in our report all information which may interest not only financiers, but also technicians, economists and administrators, in fact all those who are interested in the organization of the Belgian suburban railways, which has quite a special character of its own.

We keep separate profit and loss accounts for each line or for each group having a single capital.

Some pay dividends of 5 to 6 per cent; those are the good lines in the immediate neighbourhood of large towns or of well-populated and industrial districts. Others again pay more modest dividends, 2·5, 2 or 1 per cent.

In certain cases, if the line has cost much and a large capital has been sunk, it may happen that the first few years are bad; actually however there are only five lines on which the receipts do not cover the working expenses.

Mr. Van Nierop. (In French.) — Do all the lines have the same shares?

The President. (In French.) — Each line has its own shares.

Mr. de Burlet. (In French.) — The Belgian National Suburban Railway keeps all the accounts, but each line has its own shares, as I have already mentioned.

Mr. Van Nierop. (In French.) — Have shares already been sold?

Mr. de Burlet. (In French.) — No, the communes cannot sell their shares without authorization from the government.

*

That is, however, a general administrative rule : no commune, whether owning forests, lands, buildings, etc., can sell anything without authorization from the control authorities. The same is the case with any inscribed Government stock. Consequently, this also applies to the suburban-railway shares owned by the communes. But as I have already stated this is a general administrative rule, not one specially applying to suburban railways. The case however does not arise. Two things may happen : either the shares are very good and a suitable dividend is received, and then communes keep them because it is to their interest to do so ; or else the dividend is poor, and then the communes could not sell them if they tried; for they could only sell them below par, and they would lose the advantage resulting from the gradual growth of the traffic, which happens on the light railways just as on the main railroads.

I forgot to mention that private parties may also subscribe capital. Thus if a commune is not rich enough to subscribe for all its shares, it can apply to the landowners and manufacturers of the district. Out of a total capital of 303 million francs (£12,120,000) we have shares for hardly 4 millions (£160,000) — an insignificant amount — held by private parties.

The President. (In French.) — May they sell their shares?

Mr. de Burlet. (In French.) — Yes, they are shares to bearer. As soon as they have been delivered, the private parties can sell them; it is quite indifferent to the National Company whether they are owned by X or by Y.

The President. (In French.) — Does anybody else wish to address the meeting?

Gentlemen, I propose that we adjourn till this afternoon, at 2.30 p. m., in order to continue the discussion and put the conclusions of the report to the vote. (*Approval.*)

Meeting held 5 July 1910 (afternoon).

Mr BEHRENS, President in the chair.

The President. (In French.) — We will resume the discussion of question XVIII.

Mr. Girtanner, Federal department of posts and railways of Switzerland. (In German.) — You will allow me to add, to what has been said this morning, a few words relating to the conditions existing in Switzerland. As you can see from the table relating to Swiss railways given in the report, we have an extensive system of light or secondary railways in Switzerland. It includes standard-gauge lines and narrow-gauge lines. Most of the secondary railways are narrow-gauge lines, the gauge being 1 metre (3 ft. 3 3/8 in.). Very few lines have a gauge of less than 1 metre; with one exception, these are lines used solely by tourists and of no importance to commerce and industry. Out of 2,316 kilometres (1,439 miles) of secondary railways with movable motors, that is to say,

not including the cable railways, 718 kilometres (446 miles) are standard-gauge lines, 1,523 kilometres (946 miles) are metre (3 ft. 3 3/8 in.)-gauge lines; 61 kilometres (38 miles) have a gauge of 800 millimetres (2 ft. 7 1/2 in.) and 14 kilometres (9 miles) have a gauge of 750 millimetres (2 ft. 5 1/2 in.).

In Switzerland, the concessions for privately-owned railways are generally granted by the federal authorities, that is to say by the parliament. The federal government does not as a rule grant subventions to help the construction of light railways. An exception was made in favour of the system of the Rhetian Railway which opened to traffic the valleys of the Grisons canton. But owing to its extent and its economic importance, this system has more the character of a narrow-gauge main railroad than that of a secondary railway. The subventions received by the secondary railways are granted exclusively by the cantons and the communes. The ways of doing this are very variable. While formerly each case was a rule considered on its own merits, the growth of the secondary-railway system has given rise to a legal regulation of the cantonal contributions. In most cases the canton is compelled to contribute a certain subvention per kilometre towards the construction of the lines. Assistance in the shape of subsidies to help the operation is as a rule not granted except to enterprises which are in a precarious position, in the hope that results will improve. Besides the cantonal subventions, the communes also grant subventions, sometimes very considerable ones. The form the subvention takes is very variable. Sometimes it is a lump-sum subvention. Such was especially the case when the construction of secondary railways began. At present, the subvention is generally given in exchange for shares of the more or less deferred kind. These shares are only entitled to dividends after a given dividend, usually 4 or 6 per cent, has been paid on the debenture capital, if any, and on the ordinary stock. As a general rule, these subvention shares yield no return. It is true that in giving these subventions, the object aimed at is not so much any direct revenue, in the form of interest or dividends, as the economic benefit the enterprise will confer on the districts concerned. In order to complete this information, I may mention that it is not always that subvention shares are given in exchange for the financial assistance of the cantons and communes; in many cases also, ordinary shares are demanded in exchange for part of the amount contributed.

Besides the subventions towards the construction of the lines, the communes or cantons also grant, in some few cases, a guarantee of interest for the whole or part of the debenture capital. This system is fortunately only rarely adopted, and then generally only in cases where it is a question of the reconstruction of an undertaking which is financially weak. The sacrifices which communes, for instance, must make in such cases, are nearly always a very heavy burden on their budget.

Apart from subventions in cash, which are the only ones hitherto considered, there are also other such as the free grant of land required for the line, the supply of natural materials of construction, such as sand, gravel, stone, timber, etc. It is

above all the communes who try to facilitate the construction of a line by the help of such subventions.

The President. (In German.) — Also labour?

Mr. Girtanner. (In German.) — No, not labour.

In order to utilize a highway as roadbed for a railway, it is necessary to obtain the authorization of the owner of the highway, that is to say, the commune or the canton. The federal government exercises no authority in this direction; on the other hand, it has laid down that the conditions under which the authorities concerned authorize the utilization of the highways must be in opposition neither with the federal act of concession nor with the federal legislation.

The conditions under which the utilization of the highways by railway enterprise is authorized vary widely. Sometimes the authorization is granted without any charge, sometimes it is specified that as soon as the net profits exceed a certain rate, for instance 4 per cent, a certain amount, generally so much per kilometre, is to be paid for the use of the road. In many cases, the railways are bound to maintain the road, either only that part of it which is used by the railway, or over its whole width. Similarly, the removal of the snow in winter has often to be looked after, wholly or in part, by the railway; that is an onerous condition, particularly in mountainous districts.

The system of subventions towards the working expenses, mentioned this morning, is not applied in Switzerland, or at least only to a very limited extent. The construction and the operation of most of the secondary railways are generally in the hands of companies; the only exceptions are municipal tramways and certain small railways constructed and operated by the canton. It is under this regime, which has given good results under our Swiss conditions, that many light railways have been built which are of great importance as feeders of the main arteries of the traffic. In Switzerland, much still remains to be done from this point of view, in spite of the great extent of the light-railway system, and it is to be hoped that the efforts made will be continued energetically, especially as regards the construction of narrow-gauge light railways.

Allow me, in conclusion, to make a short remark with reference to a point mentioned in the report. It is not a correction so much as an explanation. You will find at page 11 of the report on question XVII [1], the remark that in Switzerland an order concerning the construction and operation of secondary railways was issued in 1906, which did not contain any simplification of the prescriptions which were then in force. If we read this remark, we are led to ask why the new order was issued. It is true that it includes few innovations of a practical kind; nevertheless it includes several new facilities. But it is above all of importance because it summarizes in a legal form all the regulations successively issued in order to meet practical requirements and will form, for the future, a solid legal basis which will enable the future and

(1) See also *Bulletin of the Railway Congress*, November 1909, p. 1345.

successful development of the construction and operation of secondary railways.

Mr. Forrest, Madras & Southern Mahratta Railway, British India. — The reporter of this section has not mentioned any of the 2 ft. 6 in. railways, in India, or the short feeder lines constructed out of capital raised by companies outside of the main lines.

The Gaekwar of Baroda has about 90 miles of 2 ft. 6 in., running through the fertile district of Gujerat, and earning over 7 per cent. The rates the small line charges, however, are in excess of these on the Bombay & Baroda Railway, which works the lines in question. The Maharajah of Gawlior has also constructed several miles of 2 ft. 6 in. and there is also the well known Darjeeling Line, which goes to that popular hill station.

The Government of India is also encouraging the construction of feeder railways to the main lines and they offer now liberal terms which attract the attention of natives, and encourage them to put their money into railway enterprize. It is said that out of the many millions of capital spent on Indian railways not more than about £50,000 is held in India. For these feeder lines, the government give land free and the main lines work and maintain them for 45 per cent of the gross receipts, and also give a rebate from interchanged traffic towards ensuring a dividend of 5 per cent; anything over 5 per cent is shared with the main line. The government have the right to buy the lines at the end of thirty years at not less than the cost price and not more than 20 per cent premium; the price between these limits being based on twenty-five times the average of nett receipts for the last three years.

My firm has raised capital for four of these feeders and they earn from 5 to 7 per cent; the capital is all raised, in India, in rupees.

Mr. de Burlet. (In French.) — At the end of the proposed conclusions, which are really more in the shape of a summary of Mr. Plocq's very interesting report, I read : " It is necessary that the formula of operation should allow the operator to live." I think everybody will agree with this. (*Laughter.*) " It is at present very difficult to find a satisfactory one, as expenses are continually growing. We are not far from thinking that the solution to be preferred is that of contract working as described by an Austrian company."

I shall be very grateful to the honourable reporter if he will kindly give us some explanations about these words " contract making ". I do not quite understand the meaning of this phrase.

Mr. Plocq. (In French.) — In the first place I wish to mention to you that I have expressed no personal opinion. I said in my report that I saw no way of arriving at a definite conclusion. It is certainly very difficult, seeing that expenses are continually increasing, to find a satisfactory formula; for in fact our expenses vary every day, and I think that is so in every country. They are always increasing and we cannot foresee what they will be, because legislation may change from moment to moment. Under these conditions, many of our friends have said to themselves : we cannot see how a formula can allow for this. Now in the particulars given by

an Austrian company, I have found the words " contract working ". That is to say, that any given concessionary, taking a lease for a line from a department — which is what we have to consider in France — or from the State, should no longer undertake the operation except under conditions of repayment of expenses, for instance, with an economy premium of one kind or another. That is what is meant, generally speaking, by such contract working. I am not able to give a hard and fast definition of contract working, because I know of no case where it has been applied with us. When such an application is proposed, it will evidently be necessary to discuss it thoroughly.

I have mentioned the expenses which it is impossible to know. Thus the Austrian North Western stated : " There are so many risks which the operator runs, that no formula can be accepted on another basis than that of payment of his costs for working." That is what is meant. Then it was said it would be necessary to adopt a system of contract working in which for instance the expenses would be repaid, but there would be an economy premium, of one kind or other. In such cases, the operator must be interested to reduce his expenses as much as possible, so that this must not be an amount which cannot be disputed. But this, I repeat, is only a general statement.

Mr. von Ziffer. (In German.) — In Austria, two systems exist. Under the first, which is, however, only applied in very few cases, the administration of the State undertakes the operation and by virtue of this has the right to a certain percentage of the gross receipts. But as a general rule the State undertakes the operation of local lines subject to the repayment of the net cost. If the cost of construction is not covered, the concession or contract states in certain cases that the deficit of the working expenses shall be repaid in time. In other words, the deficit is advanced by the State subject to 4 per cent interest. In this way, railways which cannot, as far as can be foreseen, meet their working expenses, are nevertheless able to acquire a concession of this kind, for those who supply the funds, that is to say the shareholders, are sure of a return of 4 or 5 per cent.

In Hungary, matters are different. I add this because one always says Austria-Hungary. In Hungary, the operation undertaken by the administration of the State Railway, is charged to the company at 50 per cent of the gross receipts; the standard form of contract stipulates for this 50 per cent of the gross receipts. The difference the Hungarian State has to look after, so that every railway concessionary knows that 50 per cent of the gross receipts, whether high or low, are available for the shareholders.

Mr. Machowetz. (In German.) — In order to supplement the information given by our vice-president, Mr. von Ziffer, I may mention that we also use a working formula in which a fixed sum is provided, for instance 4,000 kronen per kilometre (£267 per mile), from which the expenses have to be taken.

Mr. von Ziffer. (In German.) — Those cases are, however, very rare; as a rule the line is taken over subject to the repayment of the establishment charges.

Mr. Machowetz. (In German.) — But that wording of the conclusion is of little practical importance. If the local railway is constructed under good conditions from the financial point of view, it will not consent that the other party concerned should share in the profit. This way of working can only apply to mediocre lines and the operator will as a rule not agree to such a condition.

Mr. von Ziffer. (In German.) — I think that the leasing of the working is considered here. If that system of working yields any particular profit, the one who has made the leasing contract should also benefit by it.

Let us assume that the State leases the operation of a line; then, starting from a certain yield, the owner of the railway must also profit by it. That is what one wishes to express and I think that that is quire correct.

Mr. Machowetz. (In German.) — I only wish to speak about particular railways, that is, about those of which one operates the other : there hardly will be an agreement of this kind.

Mr. von Ziffer. (In German.) — I am in a general way in favour of operation by leasing. I frankly assert this and it is much to be regretted that leasing does not become the rule. No doubt there are exceptions. But this system of operation is the only correct one, for then both parties are interested.

Mr. Machowetz. (In German.) — But as experience shows, it is difficult to apply it in practice.

Mr. de Burlet. (In French.) — I congratulate myself on having asked Mr. Plocq for explanations.

I perfectly understood what is meant by contract working. I am still all the more satisfied that I brought out these explanations, because they have elucidated the discussion and cleared away every misunderstanding. As for me, I cannot agree to a conclusion which would recommend a system in which the operator would be repaid his working expenses in accordance with the expenditure accounts which he would produce. That is to incur serious trouble and great difficulties, to expose oneself to continual disputes. Accordingly in some countries a contract is made ; the operator is told : we will pay a fixed sum per kilometre for working expenses. I understand this system up to a certain point, without, however, considering that it is to be recommended ; but at all events it prevents innumerable disputes. It is quite a different matter to have to dispute the accounts for the working expenses, submitted by the operator.

All those who have to do with the operation of railways know that there is nothing more difficult than to draw up working accounts which are not open to dispute. There are elements which vary from one case to another : amortization, general expenses, repairs, insurances, etc. An operator can, if it is to his interest, try to swell his accounts, and that would nearly always be the case with the system mentioned. There is a certain elasticity in determining the working expenses and the operator will not fail to try to take advantage of this.

Mr. Plocq, *reporter.* (In French.) — I do not recommend this system.

Mr. de Burlet. (In French.) — You, however, seem to do so.

Mr. Plocq. (In French.) — Then I have expressed myself badly.

Mr. de Burlet. (In French.) — You say : " We are not far from thinking that *the solution to be preferred is that of contract working* as described by an Austrian company."

Mr. Plocq. (In French.) — I ask for permission to explain. I said this : one seeks concessionaries in France (one must speak a little about one's own country), one finds them with difficulty because they fear to be face to face with continually-growing expenses not allowed for in their contracts. Under these conditions, the Austrian Company says, after trial : " No agreements will be made except on the basis of payment of the cost of working."

Hence I ask, if that is not so, is it not possible to find a formula which would interest the operator? But as for proposing this as a conclusion, no! It is a suggestion, that is all.

Mr. de Burlet. (In French.) — Then we are in agreement. We will resume this discussion the day when a formula has been discovered for this contract working, that is to say the blue bird which one is about to seek. (*Laughter.*)

The President. (In French.) — If nobody else wishes to speak, we will now consider the drafting of the conclusions to be submitted to the general meeting.

Mr. de Burlet. (In French.) — This is the wording proposed by Mr. Plocq :

" The Congress, having considered the developments of the different systems applied, notes more especially the favourable results obtained by the Belgian system (establishment of a national suburban railway company), and thinks that it is impossible to recommend a general formula applying indiscriminately to all countries, in which legislation, customs, needs and economical conditions all vary. Everybody recognizes that in cases of leasing..."

I have taken the liberty to add, at Mr. von Ziffer's request : " *a system which it appears is to be recommended.*"

Mr. Plocq then continues : " It is necessary to find a formula enabling the operator to remunerate the capital he has engaged, but it is not necessary that this formula should be the same every where. Everybody can find in the documents submitted to the Congress " and we might add, in the discussions, " elements of a solution suitable for each country and for each individual case." I propose to add : " It, moreover, seems desirable that the question should remain among the agenda." I think, in fact, that the subject cannot be considered as exhausted.

Mr. Campiglio proposes the addition : " It is advisable that the working conditions should allow for, and be drawn up with a view to, inducing the operator to serve the public well, to develop the traffic and to increase the number of trains as necessary."

Mr. C. Sapin, Côtes-du-Nord Railway, France. (In French.) — Mr. de Burlet, with his usual lucidity, explained to us this morning the system adopted by the Belgian National Suburban Railway Com-

pany. The decision we are going to take contains an allusion to the organization of this company. Now, a little further on, there is a question of leasing. This morning, however, it was said that the lessees of the Belgian suburban lines did not supply any capital. Then what has the phrase : " enabling the operator to remunerate the capital he has engaged " to do in the resolution? There is an ambiguity there.

In France, there has unfortunately been brought forward a bill which thoroughly commits us to a very dangerous course, absolutely opposed to the system adopted by the Belgian National Suburban Railway Company; it is a question of the obligation of the concessionaries to supply a certain part of the original construction capital. Up till now that did not appear in the law, but only among precedents.

We have three different systems : we have one set of railways to which we did not supply capital; another to which we supplied 10 per cent; and a third to which we supplied 50 per cent.

Now these all give the same working profits per kilometre. Consequently, that in which we have no capital is wonderful from the point of view of yield, while that in which we supplied 50 per cent is very so-so as regards yield.

Let us state whether we praise the system of the Belgian National Suburban Railway Company, or whether we do the contrary.

The departmental administrations generally give 4 per cent for the capital supplied and they lend at 3·5 per cent; consequently they do bad business.

If we supplied capital to the extent of 15,000 or 20,000 francs per kilometre (£965 or £1,285 per mile), we should certainly be in a worse position if we had no capital engaged.

I ask therefore, yes or no, whether we vote for the Belgian system.

Mr. de Burlet. (In French.) — There is a mistake involved in that. We have not to vote for the Belgian system; that would be contrary to the traditions of the Congress.

This is the conclusion :

" The Congress, having considered the developments of the different systems applied, notes more especially the favourable results obtained by the Belgian system (establishment of a national suburban railway company)..." and then we add : " and thinks that it is impossible to recommend a general formula..."

Mr. C. Sapin. (In French.) — Go on, you will get to the leasing.

Mr. de Burlet. (In French.) — "... applying indiscriminately to all countries, in which legislation, customs, needs and economical conditions all vary. Everybody recognizes that in cases of leasing, a system which it appears is to be recommended, it is necessary to find a formula enabling the operator to remunerate the capital he has engaged, but it is not necessary that this formula should be the same everywhere..."

Mr. C. Sapin. (In French.) — There you are!

Mr. Philippe, Belgian Northern Railway. (In French.) — The operators of the Belgian Suburban railways are not bound to supply any of the original construction capital,

but a capital which is to serve as security for the National Suburban Railway Company, plus the funds necessary for building the repairing workshops, the furniture, the tools, the stores and finally the working capital.

Accordingly, it cannot be asserted that they have no capital. The capitals are reduced, it is true, but they still are of considerable importance, amounting to about 5,000 francs per kilometre (£320 per mile).

Mr. de Burlet. (In French.) — Then there is no contradiction. I was just about to make this remark.

Mr. Lembourg, National Suburban Railway Company, Belgium. (In French.) — Mr. Sapin aims at the phrase in which leasing is recommended. He finds that that phrase does not properly harmonize with the rest of the proposed conclusion.

Mr. Plocq. (In French.) — The phrase aimed at by the honourable member runs as follows : " Everybody recognizes that in cases of leasing, a system which it appears is to be recommended, it is necessary to find a formula enabling the operator to remunerate the capital he has engaged."

I proposed this wording because I thought that this could apply to all the States and all the methods of procedure.

Among the information supplied to us, we see many different methods of procedure, from Germany where there is a growing tendency for the provinces to build the lines and for private parties to operate them, to Hungary, where on the contrary private parties build the lines and the State operates them.

It follows that the formula giving the operator the means to remunerate the capital engaged by him can apply, in my opinion, to all formulæ and to all countries.

That phrase cannot offend anybody. Moreover, our conclusions should be drafted in such a way as not to inconvenience anybody. We are bound to obey the laws of our country. We have no power to give lessons to our legislators.

The President. (In French.) — We could strike out those words which might be misinterpreted.

Mr. Plocq. (In French.) — That is what I was going to ask.

Mr. de Burlet. (In French.) — We are in agreement. This then is the conclusion which we propose to you to present to the general meeting :

" The Congress, having considered the developments of the different systems applied, notes more especially the favourable results obtained by the Belgian system (establishment of a national suburban railway company), and thinks that it is impossible to recommend a general formula applying indiscriminately to all countries, in which legislation, customs, needs and economical conditions all vary.

" Everybody recognizes that the formula required should enable the operator to cover his expenses, including the remuneration of the capital he has invested ; that formula cannot be the same everywhere : everyone can draw, from the documents laid before the Congress and the discussions, the elements of the solution to be adopted in each country in each case.

" It is advisable that the working condi-

tions should allow for, and be drawn up with a view to, inducing the operator to serve the public well, to develop the traffic and to increase the number of trains as necessary.

" It is to be desired, as the subject has not been exhausted, to retain it on the agenda of the next Congress."

The President. (In French.) — If there is no opposition, I declare this wording adopted.

DISCUSSION AT THE GENERAL MEETING

Meeting held on 14 July, 1910 (afternoon).

MR. P. WEISSENBACH, PRESIDENT, IN THE CHAIR.
GENERAL SECRETARY : MR. L. WEISSENBRUCH.
FIRST ASSISTANT GENERAL SECRETARY : MR. MÜRSET.
SECOND ASSISTANT GENERAL SECRETARY : DR. A. BONZON.

Mr. de Burlet, *vice-president of the 5th section*, read

Report of the 5th section.

(See *Journal de la huitième session*, No. 6, p. 10.)

" Mr. PLOCQ, the reporter, set forth, in their main features, the laws in force affecting light railways in the different countries; he mentioned the different systems adopted by the public authorities (States, departments or provinces, communes) for giving pecuniary support to the construction or operation of these railways, and described the results obtained.

" He concluded that it was hardly possible to find any system of working capable of being uniformly applied in all cases which might occur; he mentioned that one Austrian company praised the principle of State operation.

" MR. CAMPIGLIO (*Italian local railway Union*) gave certain details of the new Italian legislation, which increased the size of the subventions granted by the government under the provisions of the former law, but on the other hand, materially increased the share the State received when the gross receipts exceeded a certain limit. According to Mr. Campiglio, this clause would prove an obstacle to the growth of the traffic, as it might be to the interest of concessionary companies not to attain this limit.

" MR. MACHOWETZ (*Austrian State Railway*) gave the meeting some figures referring to the traffic on the secondary Austrian lines in the year 1908. Mr. VON ZIFFER (*Lemberg-Czernowitz-Jassy Railway, Austria*) stated that a new law was being worked out on the subject of secondary railways and noted that this proposed law was sub-

jected to sundry criticisms by the companies concerned with such lines.

" Several delegates, including Messrs. Pedro Suarez (*Bolivian government*), Bello (*Portuguese National Railway Company*), de Souza (*Portuguese State Railway*), Waechter (*Vering and Waechter Company, Germany*), Donker Duyvis (*Semarang-Cheribon line, Dutch Indies*), Girtanner (*Swiss government*), Forrest (*Madras & Southern Mahratta Railway*), gave some interesting details about the development of secondary lines in their respective countries and the results obtained with them.

" Mr. de Burlet (*Belgian National Suburban Railway Company*) explained the legal organization of his company, which was really a public administration operated with the help of capital, half of which was usually subscribed by the State, and half by the provinces and communes interested. The different lines were leased either to local private companies, or, in certain cases, to special companies formed by the communes interested. In the case of one group of lines, this was leased to the company owning the main lines to which these lines served as feeders.

" Mr. de Burlet gave some interesting figures about the development and the traffic of the Belgian National Suburban Railway system.

" He found that the system of State operation referred to by Mr. Plocq at the end of his report, was difficult to apply and might give rise to abuses and to disputes.

" Mr. Plocq recognized that there was truth in this criticism, but objected that taking into consideration the continually growing expenses which operators (both of main lines and of secondary lines) had to incur, more especially in consequence of the different social laws passed in many countries, it was no longer possible to make working contracts which did not expose the operators to serious losses. This uncertainty was calculated to discourage private enterprises from undertaking the operation of secondary lines.

" After several remarks on this point, more especially by Mr. C. Sapin (*Côtes-du-Nord Railway, France*), the section agreed to submit the following conclusions to the general meeting."

The President. — The following are the

CONCLUSIONS.

" The Congress, having considered the
" developments of the different systems
" applied, notes more especially the
" favourable results obtained by the
" Belgian system (establishment of a na-
" tional suburban railway company), and
" thinks that it is impossible to recom-
" mend a general formula applying indis-
" criminately to all countries, in which
" legislation, customs, needs and econ-
" omical conditions all vary.

" Everybody recognizes that the formula
" required should enable the operator to
" cover his expenses, including the
" remuneration of the capital he has in-
" vested; that formula cannot be the same
" everywhere : everyone can draw, from
" the documents laid before the Congress
" and the discussions, the elements of the
" solution to be adopted in each country
" in each case.

" It is advisable that the working condi-
" tions should allow for, and be drawn
" up with a view to, inducing the operator
" to serve the public well, to develop the
" traffic and to increase the number of
" trains as necessary.

" It is to be desired, as the subject has
" not been exhausted, to retain it on the
" agenda of the next Congress."

— These conclusions were confirmed by the general meeting.

APPENDIX

Corrigenda to the report.

Page XVIII-13 of the separate issue No. 10 and of the *Proceedings* (page 1275 of the *Bulletin* of October 1909), lines 17, 18, 19 and 20 from the top, *instead of :* " 5,690 kilometres (3,535 miles), 2,870 kilometres (1,783 miles) and 2,820 kilometres (1,752 miles) ", *read :* " 2,065 kilometres (1,283 miles), 930 kilometres 578 miles) and 1,135 kilometres (705 miles) ".

Same page, line 7 from the bottom, *instead of :* " 2·33 per cent ", *read :* " 2·34 per cent ".

Page XVIII-15 (page 1277 of the *Bulletin*), lines 14 to 18 from the top, *read :*

" 16 earned no dividend;
36 earned one of up to 1 per cent;
36 earned one of up to 2 per cent;
55 earned 3 per cent;
23 earned 4 per cent;
46 earned from 5 to 10 per cent and
4 earned more than 10 per cent."

Page XVIII-19 (page 1281 of the *Bulletin*), lines 6, 7 and 8 from the top, *instead of :* " Out of a total capital of 639,871,600 kronen (£26,618,658). there are : 443,449,300 kronen (£18,447,490) in preference shares : 196,442,300 kronen (£8,172,000) in ordinary shares ", *read :* " Out of a total capital of 639,871,600 kronen (£26,618,658), there are : 443,449,300 kronen (£18,447,430) in preference shares : 196,422,300 kronen (£8,171,168) in ordinary shares ".

SECTION V : LIGHT RAILWAYS

[625 .616 & 625 .617] QUESTION XIX

LOCOMOTIVES AND ROLLING STOCK

OF

NARROW-GAUGE LIGHT RAILWAYS

A. — *Types of the latest locomotives used on narrow-gauge light railways, with due consideration to the profile of the line and the class of traffic.*

Is it advisable : 1° to protect the wheels and the moving parts by a metal cover ; 2° to have a foot-plate at each end of the locomotive? What regulations are there on the subject?

B. — *What are the latest types of carriages and wagons used on narrow-gauge light railways?*

Reporter :

All countries — Mr. Moriz Jessen, engineer, inspector, Austrian Southern Railway.

QUESTION XIX

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N. B. — Vide also the separate issue (in red cover) No. 64.

[625 .616 & 625 .617]

REPORT

By Moriz JESSER,

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INTRODUCTION.

Subject XIX, which is to be discussed at the eighth session of the Railway Congress, may be divided, as far as littera *A* (locomotives) is concerned, into three sections, which are entirely independent of each other. These are :

1° The principal questions, namely the most recent types of locomotives, together with two supplementary questions, namely:

2° The advisability of protecting the moving parts, and

3° The advisability of having two footplates.

In accordance with this subdivision of the subject, the report itself as well as the appendices are divided into the corresponding three sections. Each appendix contains, in the first place, the list of questions, secondly, the list of the railway administrations who have supplied information on the subject, and thirdly and fourthly, the particulars and answers themselves, which, according to their importance, are either reproduced in full or only in the form of extracts. It was not possible, both in the interests of conciseness and on account of the limited space available, to reproduce all the numerous sketches and drawings which were received, and it was necessary to limit oneself to a selection of them.

Altogether, one hundred and twenty-six administrations have answered the list of questions, of whom forty-one have sent very complete information about the types of locomotives they have in use, and have given, in more or less detail, their views on the subject and the reasons for these views.

In consequence of the great amount of information available, the investigation of the different types of locomotives has become so voluminous, that is was not possible, within the limits of time and space available, to deal with littera *B* concerning carriages and wagons used on narrow-gauge railways, with the thoroughness the importance of the subject demands; it was therefore considered advisable to limit the report which follows, to littera *A*, in order to be able to complete this part of the subject; and it is left to the Congress to discuss the littera *B* later on.

SECTION I.

QUESTION *A*.

Latest types of the locomotives used on narrow-gauge railways, with due consideration to the profile and the class of traffic of the lines.

I. — General considerations.

Particulars sent by forty administrations are available for the consideration of this subject. These include one hundred and seven types of locomotives for eleven different gauges, nine of which differ materially from each other, while two, owing to the

small differences of 1 and 2 millimetres ($^3/_{64}$ and $^5/_{64}$ inch) respectively, will not be considered separately. The chief particulars of ninety-four of these types are given in the third part of appendix I, while the most important types are described in detail in the fourth part of appendix I, diagrams of the axle-arrangement being given; thirteen types, which only differ from others of the same railway administration, are not specially described, but only noted. The classification, according to gauge, of the different administrations and types, and the corresponding number of locomotives, are given in the following table:

Gauge, in millimetres.	Number of Administrations.	Types.	Locomotives.
A) 610	2	2	8
B) 750	4	6	172
C) 760 / 762	9	24	195
D) 785	1	4	55
E) 890 / 891	2	10	104
F) 914	4	17	36
G) 950	1	1	12
H) 1,000	17	31	176 + 561 (1)
J) 1,067	4	12	54
Number 11.	44 (2)	107	1,373
or 9.	or 40	On the average, 12·8 locomotives per type.	

(1) As regards 561 locomotives of the Belgian National Suburban Railway Company, which are of two very similar types of the C class, it is not stated how many of each run on each of the two gauges used (1,000 and 1,067 millimetres); consequently the total applies to the two gauges jointly.
(2) Four administrations use two gauges.

Thus on the average, there are about 12·8 locomotives per type, and if we exclude the 561 locomotives of two types which all belong to one large undertaking, we only have 812 locomotives to 105 types, or on the average only 7·7 locomotives per type.

Now although individual details of a few of the types enumerated may be interchangeable, it cannot be overlooked that the very small average number of locomotives, built to one set of drawings and patterns and templets, and requiring other special appliances and tools, must have an unfavourable influence not only on the prime cost of the locomotives, but also on their cost of maintenance.

When making a retrospect over the creative work of some tens of years in connection with a special subject, it is undoubtedly justifiable to consider measures which seem suitable to avoid or reduce disadvantages which have resulted from too great individualization when the lines were designed. In this way, it is probable that a very injurious in-

fluence was exercised by the creation of such a large number of gauges, which in some cases only differ by from 10 to 23 millimetres ($^{13}/_{32}$ to $^{29}/_{32}$ inch), and some of which could have been eliminated at a very trifling expense.

This subject is however at present outside our scope, and we have to deal with the gauges as they exist. But the existing conditions lead to the conclusion that it is advisable, when selecting locomotive types for a new line or when ordering locomotives for an existing line, to pay attention, when considering prices, to the above considerations, and to try to limit the excessive growth in the number of different patterns. It can not be overlooked, in this connection, that some administrations have been swayed by considerations of the kind, for in some cases they have given repeat orders for locomotives of the original type after eleven, thirteen and even fifteen years.

In our case, it seemed advisable to classify the different locomotives in the first place according to gauge, in order to make comparison possible and to facilitate it, and only consider the official classification of the administrations concerned as secondary. The classification made on this basis is given in the second part of appendix I.

A first glance at the rather extensive array of figures shows that in spite of its extent it does not offer a general view of all the locomotives of those administrations who have sent answers to the list of questions, but that many of the administrations have limited themselves strictly to the wording of the question, and have only given particulars of the types of the latest locomotives, while others have given a more or less complete account of their whole locomotive stock. Now although it is self-evident that no comprehensive statistics can be drawn up on such a basis, which would no doubt be of great value for the study of the subject, yet nearly all types were included in the third part of appendix I. The point of view taken was that the progress made in those types, which have become worked out by the better utilization both of the materials used in construction as well as of the materials consumed and as a result of the experience gained, can be better gauged by a comparison with the original designs, than if the new designs alone are considered.

Before we begin the consideration of the individual types, we will make a few remarks on the points of view from which we can examine the cumbrous and apparently intractable mass of figures and data. The most important properties, which interest us in connection with a locomotive and especially a narrow-gauge locomotive, running on a line with a difficult profile and plan, include the possibility of smooth running round curves at a proper speed, and a tractive force or power suited to the needs of the traffic, without exceeding the maximum axle-loads admissible with a light road and road-bed.

The following table of the limits of the minimum radii of curves and of the maximum gradients (classified according to gauge) on the different lines this report deals with shows the magnitude of the demands made in some cases on the locomotives, as regards the curves and gradients on the line.

Gauge, in millimetres.	Minimum radius of curves, in metres.		Maximum gradient, per mil.	
	Greatest.	Smallest.	Steepest.	Most gentle.
A) 610	100	61	30	16·6
B) 750	106·7/64	40/30	40	15
C) 760/2.	152·4	50	32·4	6·6
D) 785	...	40/35	40	...
E) 890/1.	300	148/119	27·6	16
F) 914	70	47	82·5	25·6
G) 950	...	100	25·0	...
H) 1,000	450	21	58·82	0
J) 1,067	322	25	70·0	6·6

Remarks. - The smallest radii of curves at switches are given as the denominators of the numerators which give the figures for the open line.

On the other hand, this table shows that the conditions on some of the narrow-gauge lines are more favourable than on some standard-gauge lines.

Now as regards the kernel of the question, the power of the locomotives, the information given by a few of the administrations only do not render it possible to make any proper comparison between the locomotives of different railways; nor was this to be expected, because many special conditions affect the direct comparison both of the train-loads hauled, and of the horse-power actually produced, too much to make it possible to use them for purposes of direct comparison. When we consider the train weight on a given gradient, and the speed there obtained, there are so many disturbing influences at work that no comparison can be made. Such are :

The possibility of overworking the boiler on short up-gradients by allowing the water-level to become temporarily lowered, and feeding it up again while on the next more favourable section; or the possibility of favourable distribution of the speed over smaller sections having different gradients. These varying conditions form an obstacle to the determination of the actual power produced, from the figures given. A further source of error arises from the use of fuel of different origins, or even of different qualities when obtained from one and the same coal pit, even if its calorific value or evaporative power is correctly given, for even these figures are liable to vary within wide limits. In addition to these disturbing factors, we must also mention the varying intensity of the fire, the difference in the skill of the locomotive crews, and many other influences which can not be calculated. Similar errors occur in the

comparison of the statements as regards the horse-power produced at different places and under different conditions, although these figures may be perfectly correct under the individual conditions concerned.

Even a practised eye will find it impossible, at first glance, to make any comparison of the different types on a uniform basis, as so many factors are involved, such as heating surface and its distribution, working pressure, superheating, compounding, quality of the fuel, briskness of the fire, etc. In order to make such a comparison possible, it is necessary to determine quality coefficients for a definite kind of fuel and a standard working pressure in the boiler, from its dimensions and other particulars as given above; the quality coefficients would naturally only apply under the particular conditions assumed and might be materially higher or lower under other conditions.

In the case of the large boilers of standard-gauge locomotives, it is usual to take as basis the evaporative power or the output per unit of the fuel used; but this is not advisable in the case of narrow-gauge locomotives, for we must allow for the less favourable conditions of the combustion of coal on small grates, especially if the coal contains much ash or, still worse, forms clinker; also for the smaller length of the smoke tubes, which results in a less economical utilization of the heat generated by the combustion, and finally for many other similar losses which, as experience shows, forms a greater proportion of the whole than in the case of large units of traffic.

In order to obtain useful coefficients for this particular purpose, the administration of the Austrian Southern Railway carried out a number of coal tests on some of its narrow-gauge lines, where there are sections with long gradients which are fairly uniform. Different kinds of coal, chiefly of better quality, were used, and all the measurements and observations were taken as carefully as possible in order to obtain a correct representation of the conditions there obtaining. The output of power was calculated from the train weights and the gradients, and the following results were obtained, besides others of great value to the locomotive engineers of narrow-gauge lines, but which do not fall within the scope of the present report :

Small locomotives, with a grate area which does not differ by much from 1 square metre (10·76 square feet), using saturated steam and working with twin cylinders, give, when good Cardiff coal is used, and the draft is as brisk as possible, as is most advantageous to a long life of the fire-box and of the tubes, a continuous output in horse-power (L) equal to the working pressure in metric atmospheres (p) multiplied by the sum of the fire-box heating surface (B) plus quarter the smoke-tube heating surface in square metres (R); *i. e.* :

$$L = p\left(B + \frac{R}{4}\right).$$

This empirical formula can make no claim to mathematical accuracy such as is attempted in calculating purely-mechanical relations; for, taking one item only, the power does not vary directly as the working pressure. Yet the formula can be used for determining the power of

locomotives within the limits indicated, under the conditions here assumed, sufficiently approximately for practical purposes.

In the case of locomotives using superheated steam, and with compound working, the power estimated as shown above will require to be increased. Each of these two improvements makes it possible, under favourable conditions, to obtain up to 20 per cent more power out of the steam produced. It must however not be overlooked that locomotives, when on the steepest gradients, have as a rule to give materially more power than would correspond to the best utilization of the steam produced or of the coal burnt; for in addition to this, there is also the cost of the locomotive crews, which has a much more unfavourable influence of the cost per unit of power of the locomotive when the output of power is small, than a somewhat greather consumption of coal and a correspondingly-greater fatigue of the boiler and engine. In order to obtain the lowest total expenditure on tractive power per ton-kilometre, the locomotive must therefore do more work than if the object aimed at was the best utilization of the fuel. These reasons make it advisable not to allow for the increase in power the maximum values determined in the experiments, but to allow in each case about 10 per cent, paying due regard to the existing traffic conditions.

The figures so obtained are given in the tables of the chief particulars in the third part of appendix I, while the fourth part, which merely reproduces the statements of the administrations, only gives the power as given by the administrations. On the whole, the two sets of figures show a rather satisfactory agreement, taking the different calorific values of the fuel used into consideration; a few greater discrepancies are no doubt due to variations in the conditions mentioned above, probably more especially to differences in the briskness of the fire.

Nevertheless, the figures given may be considered as a basis of comparison which may be used generally, for it certainly would be possible to increase the output of the locomotives which have a similar heating surface, for which lower figures are reported, by forcing the steam production, should this appear to be desirable in any individual case.

If we now pass over to the consideration of the locomotive used on the different gauges, we have to mention, besides the particulars given in the tables in the fourth part of appendix I, the following individual peculiarities.

2. — Noteworthy types of locomotives.

A. — *Railways with a gauge of 610 millimetres (2 feet)* [1].

Particulars concerning lines of this gauge are only given by two administrations of State railways in the South African colonies of Great Britain.

Rather difficult conditions exist as regards curves and gradients on these lines, such as also exist on most of the European narrow-gauge railways, having a wider gauge; the latter sometimes even show

(1) The index numbers and letters used in the text correspond with those used in the tables and descriptions given in appendix I.

worse conditions, as on the South African lines in question the minimum radius is stated to be 61 metres (3·05 chains) and the steepest gradient 30 per mil.

2) Of the two locomotive types described, that of the Natal Government Railways (fig. 1), used on the Estcourt-Weenen branch, of the most recent type, is of the 2 C 1 class, and is distinguished by having a very long wheelbase as compared with the curves run over; the total wheelbase is 5,409 millimetres (17 ft. 8 $^{15}/_{16}$ in.), while the rigid wheelbase is 1,752 millimetres (5 ft. 8 $^{31}/_{32}$ in.), and this arrangement made it possible, although carrying a considerable weight of stores, to provide a locomotive having a large heating surface (62·6 square metres [673·85 square feet]) while keeping the axle-load moderate (5·815 tons [5·723 English tons]); thus this locomotive, while working at a pressure which can not be called high, gives the high figure of 215 horse-power, *i. e.* 3·53 horse-power per centimetre (8·84 British horse-power per inch) of width of gauge and 8·13 horse-power per ton of gross weight (8·15 British horse-power per English ton).

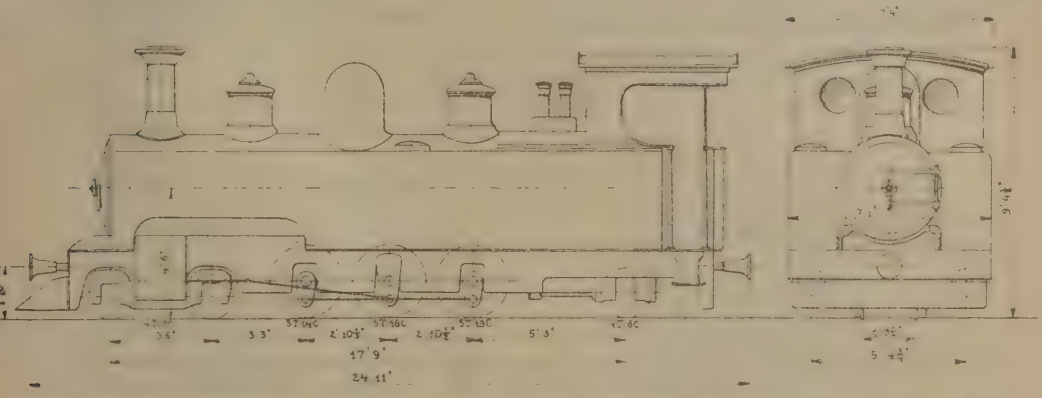


Fig. 1. — Natal Government Railways (Africa). — Tank locomotive, Stuartstown line. 610 millimetres. (Gauge 2 feet).

This locomotive is superior, both as regards its absolute power, as well as regards these ratios to gauge and weight, to the average of all the narrow-gauge locomotives. On the other hand, the adhesive weight and the maximum speed, and their relation to the power, are to be considered as moderate, as those locomotives can nearly attain the maximum speed when the former is fully utilized.

B. — *Railways with a gauge of 750 millimetres (2 ft. 5 $^1/_2$ in.)*

As regards locomotives for this gauge, particulars are sent by four administrations in Germany, Egypt and Russia.

The Saxon State Railway has a line 1) which has curves with a radius of 50 metres (2 $^1/_2$ chains) on the open line, and of 43 metres (2·15 chains) at switches, and the steepest gradient is 40 per mil. It has

had two noteworthy types of locomotives constructed.

The first, a B + B tank locomotive on the Meyer system (fig. 2), has four cylin- *a)*

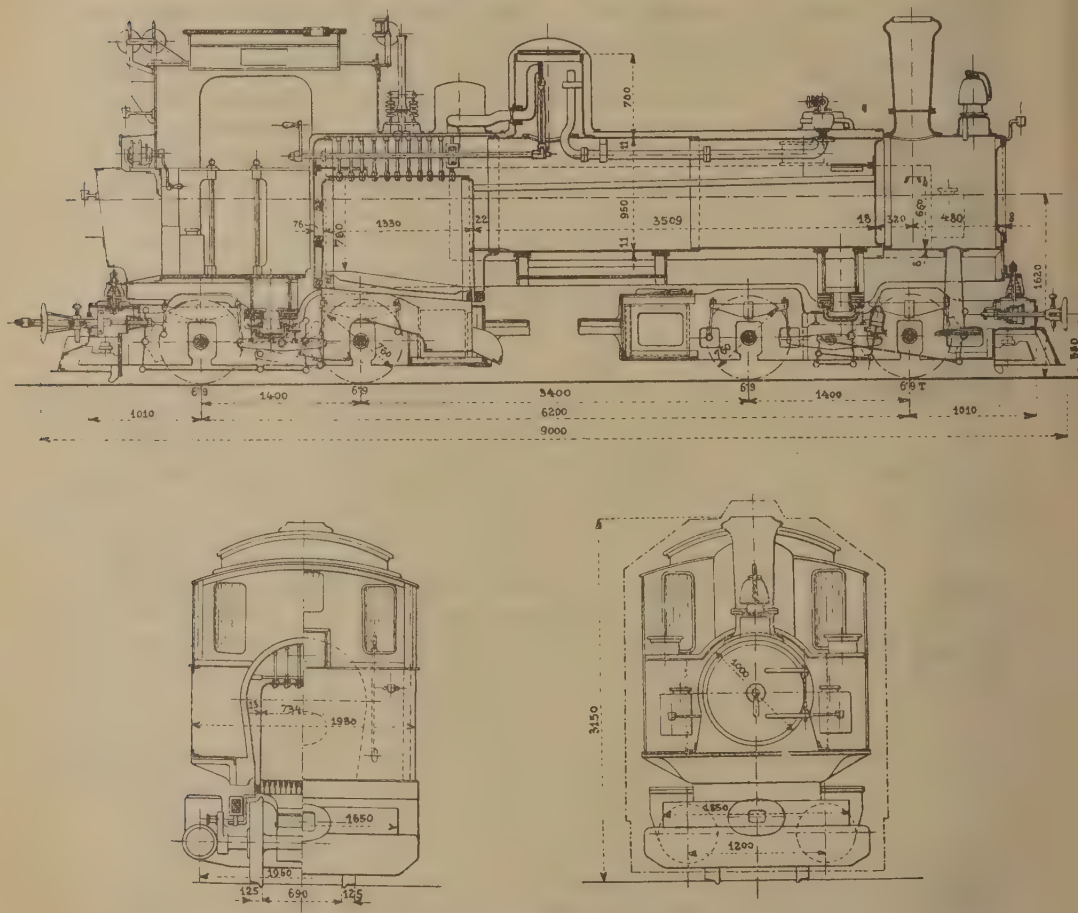


Fig. 2. — Saxon State Railway. — Four-axled narrow-gauge 750 millimetres (2 ft. 5 1/2 in.) compound tank locomotive (Meyer design).

ders and is a compound. Forty-five such locomotives were acquired during the years 1892-1908, and this proves that the administration obtained good results with this type. The whole load is carried on a large wheelbase, of 6·2 metres (20 ft. 4 in.), so that the load only amounts to 4·42 tons per metre (1·53 English tons per

foot) of wheelbase. The maximum axle-load of 6·9 tons (6·8 English tons) can not be called high; this gives the considerable adhesive weight of 27·4 tons (27 English tons). Assuming the coefficient of adhesion to be $^1/_6$ and the traction resistance to be 10 per mil, this corresponds on the steepest up gradient to an available drawbar pull of 3,200 kilograms (7,055 lb.). The other dimensions we do not materially differ from those of locomotives of similar design.

b) The second type of the same administration is a D tank locomotive (fig. 3) with a rather greater adhesive weight, and accordingly gives, assuming the same conditions as in the last case, an available drawbar pull of 3,345 kilograms (7,374 lb.) on the steepest gradient. The adoption of the Klien-Lindner system for the first and the last axle has made it possible to run over the existing sharp curves in spite of the large wheelbase of 3,900 millimetres (12 ft. 9·$^9/_{16}$ in.) of the coupled axles. In consequence of the high working pressure of 14 atmospheres and of compounding, the power abtained amounts to 250 horse-power, so that this is the most powerful locomotive of this gauge. This corresponds to 3·33 horse-power per centimetre (8·34 British horse-power per inch) of gauge and to 8·7 horse-power per ton (8·72 British horse-power per English ton) of locomotive, and thus this locomotive is superior to the average of all the types.

2) The administration of the Wurtemberg State Railway has a B + B compound locomotive on the Mallet-Rimrott system, (fig. 4) four cylinders, used on its lines, with where conditions are favourable, the steepest gradient being 25 per mil and the radii of the sharpest curves 100 and 50 metres (5 and 2 $^1/_2$ chains) respectively. This locomotive has the same adhesive weight as the previous type and gives similar power, so that what was stated in the last case also applies to this; on the gentler gradient on which this locomotive is used, the available drawbar pull will be about 3,780 kilograms (8,333 lb.).

Finally, we may mention a locomotive 4*a*) with separate tender of the *Première Société des chemins de fer secondaires en Russie*, of the D class; ninety-one of these have been acquired. As the curves which have to be run over are moderate (radii 106·7 and 64 metres (5·335 and 3 2 chains) on the open line and at switches respectively), the wheelbase could be made longer without any special arrangements, and if coal were used for firing 220 horse-power would be obtained, so that these locomotives would then come third as far as locomotives of this gauge are concerned; fired with wood, it gives 197 horse-power according to the statement of the administrations. The ratio of power to total weight, owing to the use of a separate tender, is naturally not so favourable as in other cases; it was however necessary to put up with this disadvantage, in order to be able to carry the large quantity of stores required under the existing conditions, as regards line and fuel. A similar second type is designed as a tank locomotive, and is less powerful.

C. — *Railways with a gauge of 760 or 762 millimetres (2 ft. 5 $^{15}/_{16}$ in. or 2 ft. 6 in.).*

This gauge has been adopted by a large number of administrations, so that, next

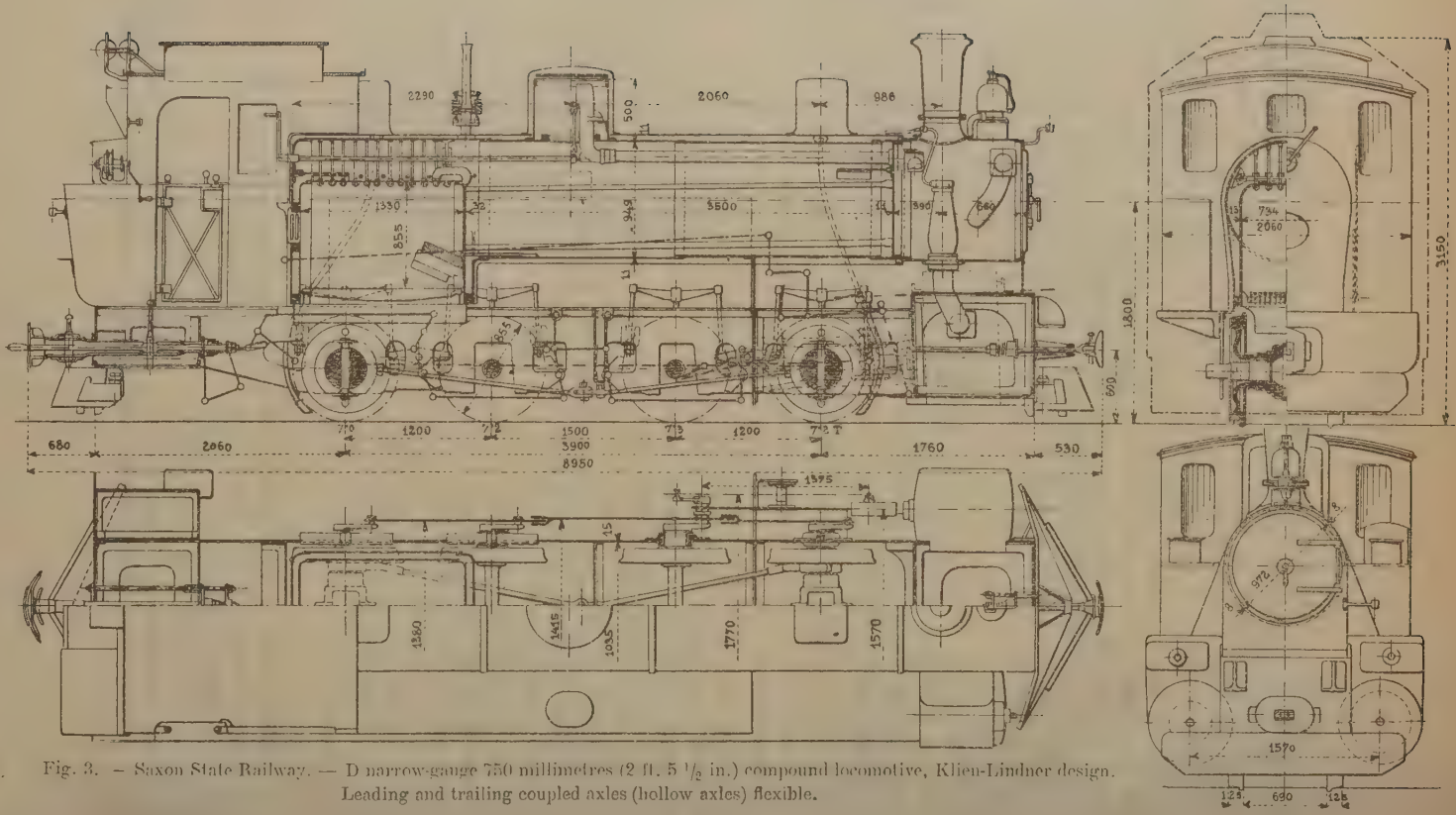


Fig. 3. — Saxon State Railway. — D narrow-gauge 750 millimetres (2 ft. 5 1/2 in.) compound locomotive, Klien-Lindner design. Leading and trailing coupled axles (hollow axles) flexible.

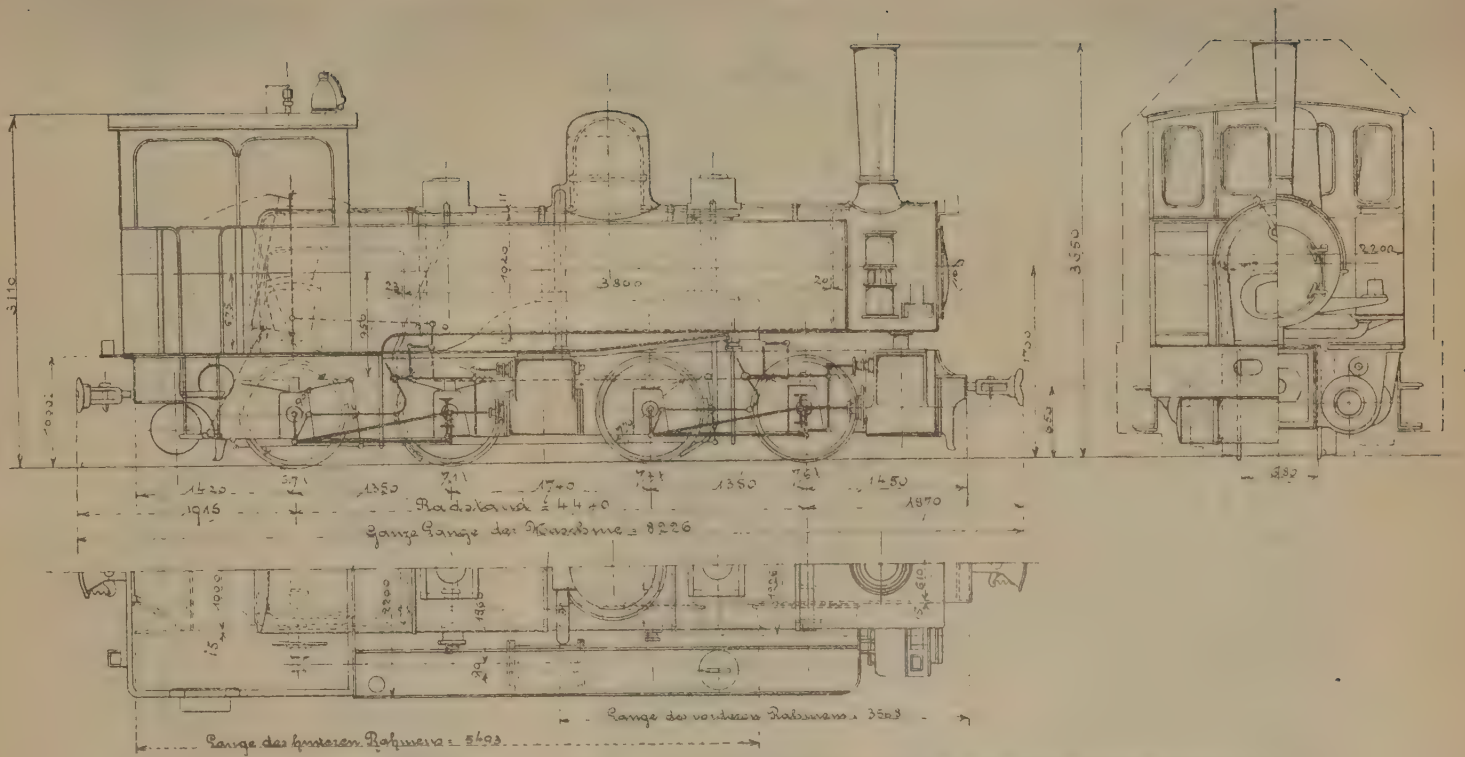


Fig. 4. — Wurtemberg State Railway. — B + B tank locomotive, type *Tssd* for narrow gauge lines 750 millimetres (2 ft. 5 ½ in.).

Explanation of German terms : Radstand = Wheelbase. — Ganze Länge der Maschine = Length over buffers. — Länge des hinteren Rahmens = Length of back frame. Länge des vorderen Rahmens = Length of front frame.

to the gauges of 1,000 and 1,067 millimetres (3 ft. 3 $^3/_8$ in. and 3 ft. 6 in.), it is most strongly represented. It is used on nine railways, and there are one hundred and ninety-five locomotives of twenty-four different types. Five of these railways are in Austria-Hungary and four are in the Empire of India.

The conditions as to curves and gradients on the lines described by the administrations in Austria-Hungary, are it is true not so very bad, but are yet rather difficult ones, as the minimum radii vary, with one conception, between 50 and 80 metres (between 2 $^1/_2$ and 4 chains), and the steepest gradients exceed 25 per mil on most lines, and even attain 32·4 per mil.

The following types are specially considered owing to some particular feature.

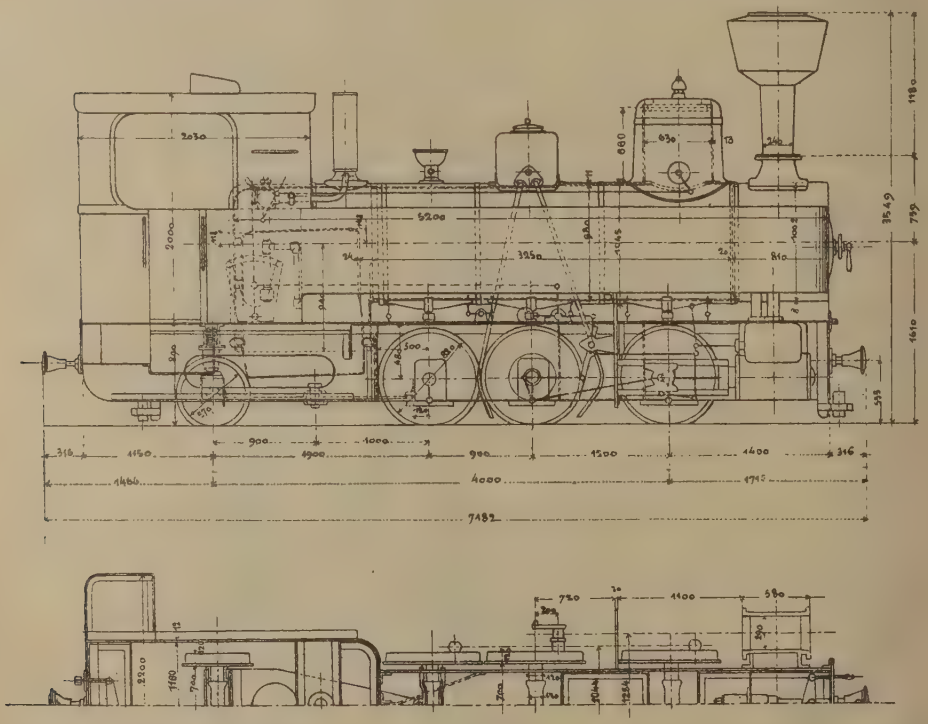


Fig. 5. — Austrian State Railway. — Narrow-gauge tank locomotive, series U, gauge 760 millimetres (2 ft. 5 $^{15}/_{16}$ in.).

1*b* and *c*) Two types (fig. 5 to 7) of the Austrian State Railway; namely a C1 tank locomotive, and a C2 tank locomotive; both have become developed by the improvement of an older weaker C1 type (fig. 5) of which fortyone were in existence. The first of these

two types (fig. 6) has an adhesive weight of 22·9 tons (22·5 English tons), and on the steepest gradient of 32 per mil, assuming the coefficient of adhesion to be $^1/_6$, the available drawbar pull is 2,660 kilograms (5,864 lb.). The second (fig. 7) has a smaller adhesive weight and accordingly gives a smaller drawbar pull. The first has axle-loads of 7·7 tons (7·6 English tons), which may be considered considerable for this gauge; its total wheelbase is 4,000 millimetres (13 ft. 1 $^1/_2$ in.) and the average load amounts to 6·8 tons per metre (2·04 English tons per foot) of track, while with the second type the load is 5·5 tons per metre (1·65 English tons per foot) of track.

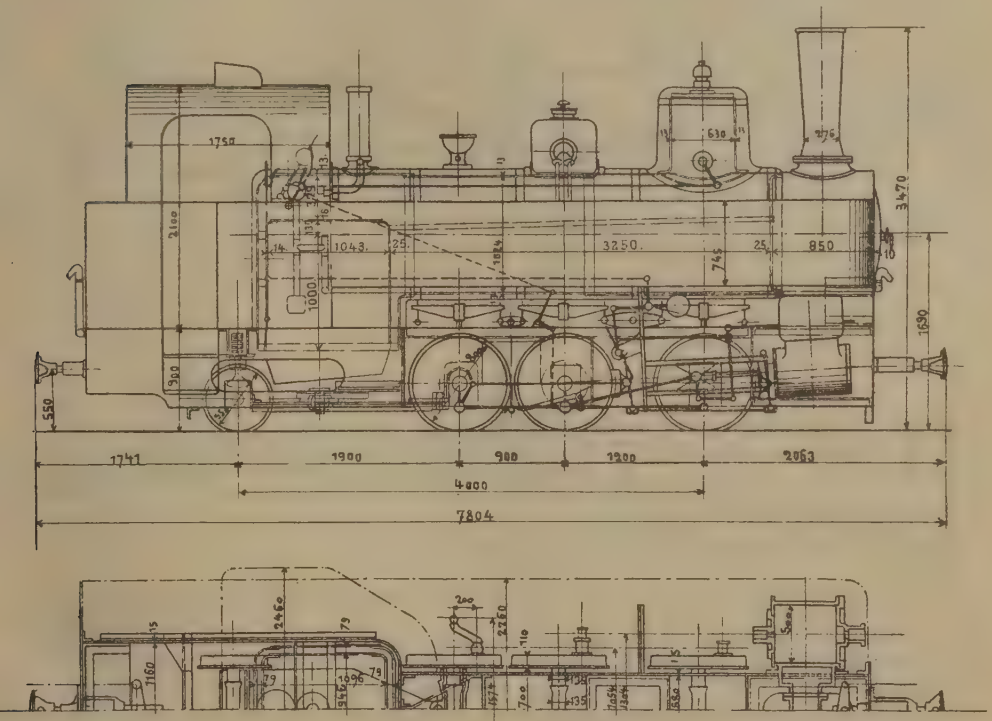


Fig. 6. — Austrian State Railway. — Narrow-gauge compound tank locomotive, series Uv, gauge 760 millimetres (2 ft. 5 $^{15}/_{16}$ in.).

The rather large wheelbase of the first type runs well round sharp curves, as the Bissel truck of the trailing carrying axle effects the corresponding lateral displacement of the last coupled axle. In the second type the two trailing carrying axles are in a bogie below the fire-box, and smooth running on the curves is facilitated by having the leading driving wheels made without flanges.

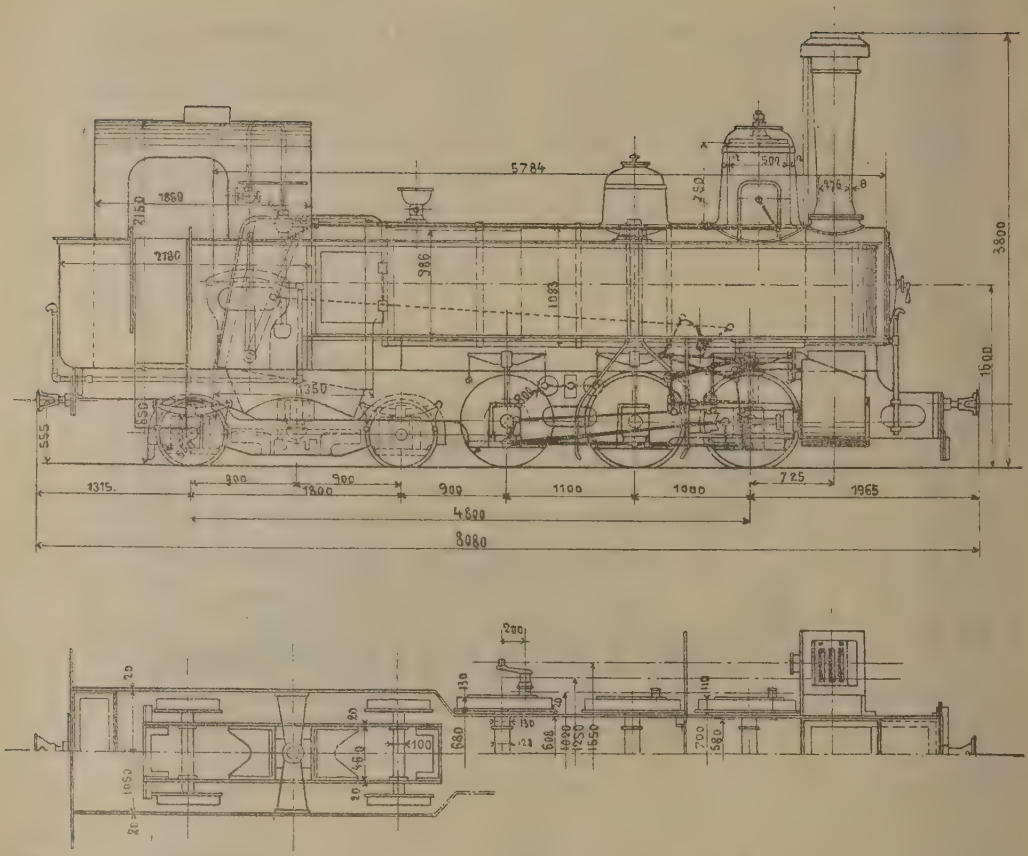
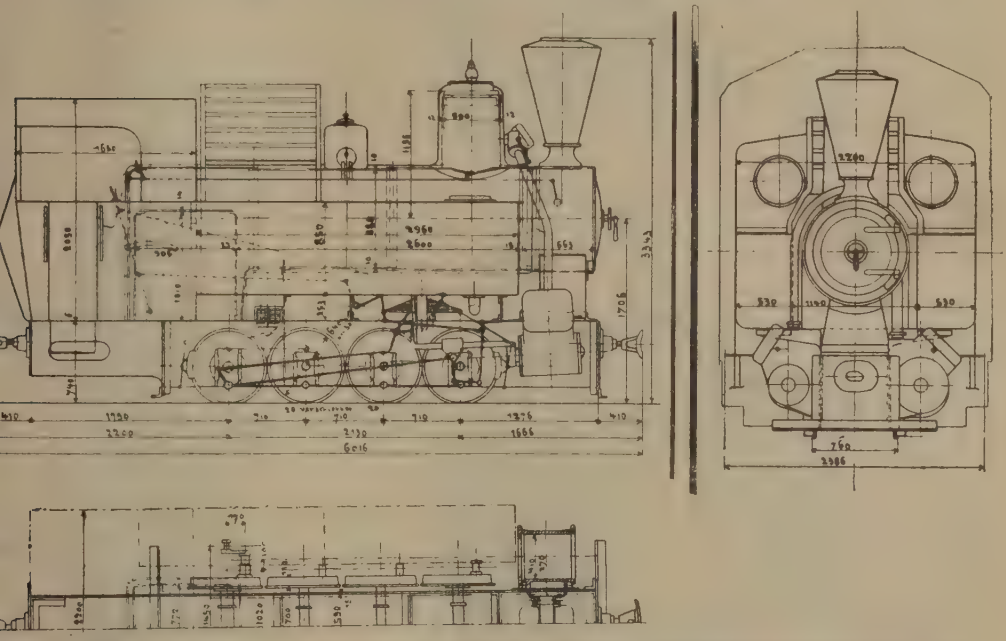


Fig. 7. — Austrian State Railway. — Compound tank locomotive, series Yv, gauge 760 millimetres (2 ft. 5 $^{15}/_{16}$ in.).

Both types are distinguished by the power produced. The first gives 270 and the second 280 horse-power; these correspond to the high ratios of 3·54 and 3·68 horse-power per centimetre (8·87 and 9·22 British horse-power per inch) of gauge and of 9·76 and 10 57 horse-power per ton (9·78 and 10 59 British horse-power per English ton) of locomotive respectively, and this is due to the rather high working pressure of 13 atmospheres (191·18 lb. per square inch) and to the compounding; these quality coefficients are higher in this case than in that of all the other locomotives of all the gauges which we are dealing with.

Among the other types of locomotives [2] of the Austrian railways, we have to mention the D tank locomotive of the Bukovina Local Railway (fig. 8), which thanks to a high working pressure and to compounding gives 150 horse-power, although

it has the very low axle-load of only 4·2 tons (4·1 English tons) and the small total weight of 16·8 tons (16·5 English tons); thus it gives 8·95 horse-power per ton (8·97 British horse-power per English ton) of locomotive, and must be classified in this respect as belonging to the locomotives of economic design.



8. — Bukovina Local Railway. — D compound tank locomotive, series Cv, gauge 760 millimetres (2 ft. 5 $^{15}/_{16}$ in.).

The Hungarian railways also describe two noteworthy types :

The Arad-Csanad Railway describes a A 1 A tractor in which each pair of driving wheels are on a flexible axle, each driven by a two-cylinder de Dion-Bouton engine with enclosed toothed-gear transmission. The vertical boiler works at a pressure of 18 to 25 atmospheres (265 or 368 lb. per square inch), and the power produced is stated to be 75 horse-power.

The Kaschau-Oderberg Railway describes a D tank locomotive with the large wheelbase of 4,000 millimetres (13 ft. 1 $^{1}/_{2}$ in.). The Klien-Lindner system is applied to the first and to the last axle, so that it can run round curves having a radius of 60 metres (3 chains). As the whole weight of the locomotive is utilized as adhesive weight, the available drawbar pull on the steepest gradient of 22·5 per mil is 3,220 kilograms (7,099 lb.).

The lines described by the railway administrations in the Empire of India, which have a gauge of 762 millimetres (2 ft. 6 in.), show much more favourable

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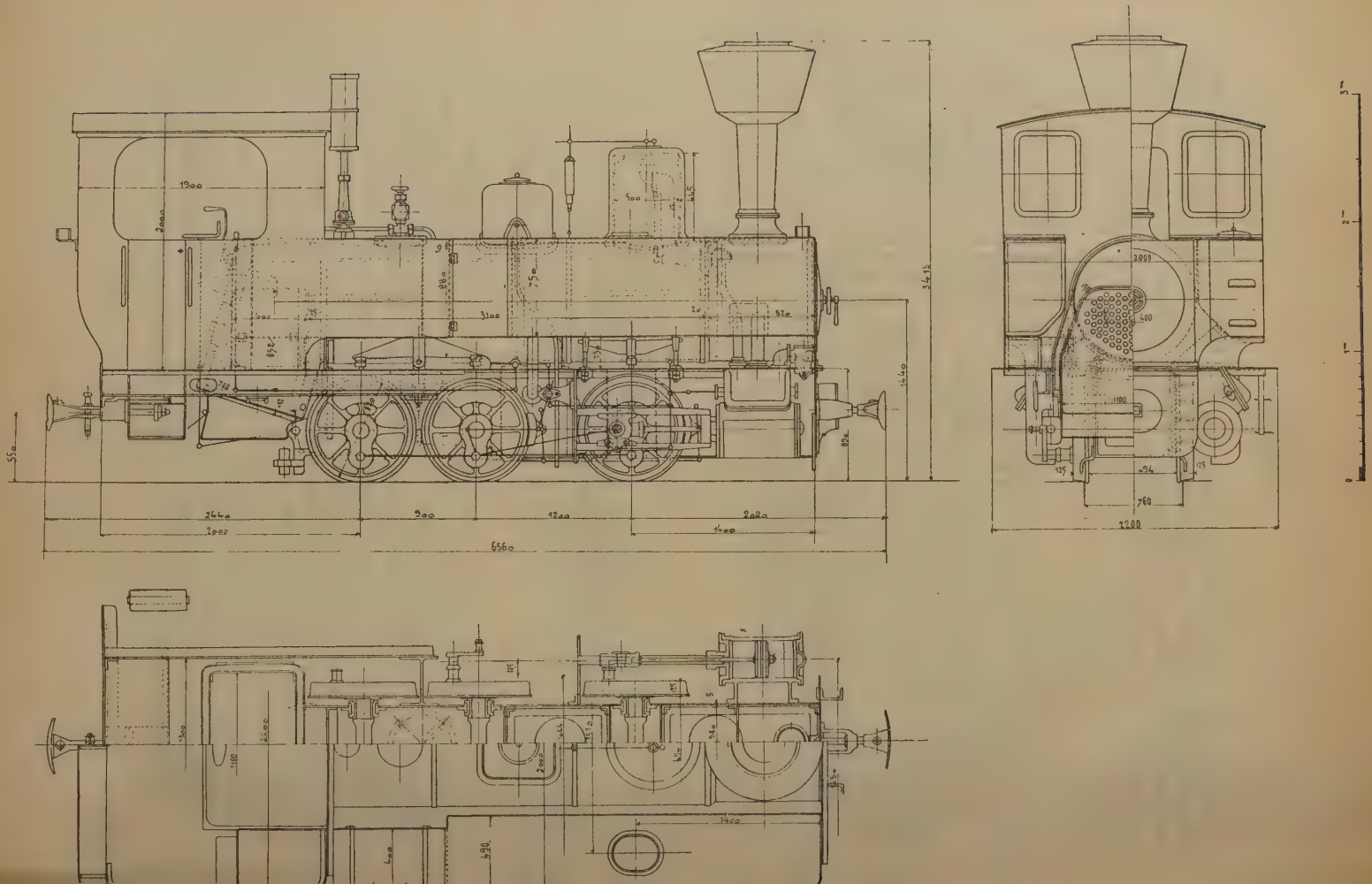
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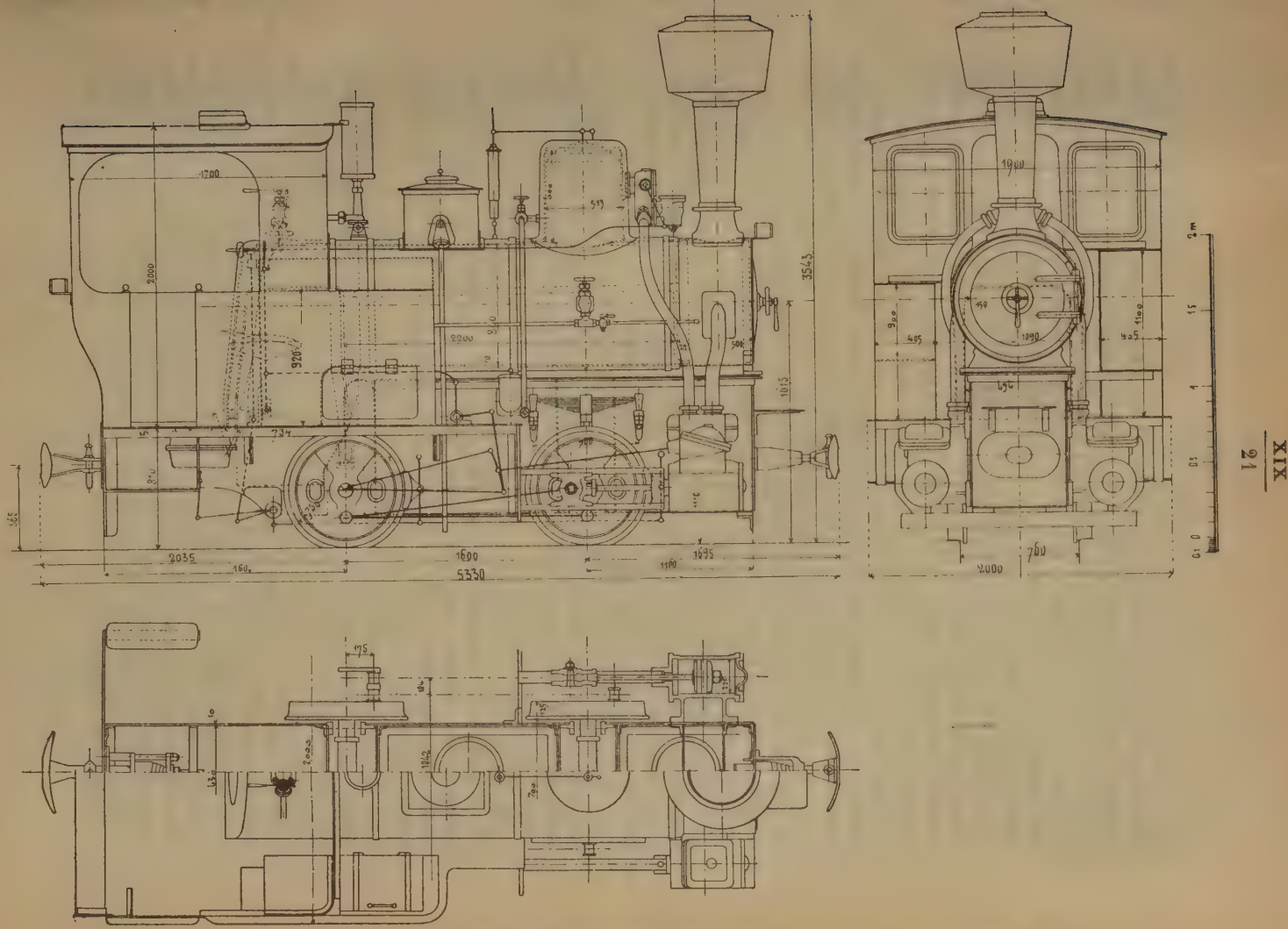

Fig. 10. — Styrian Railway. — Narrow-gauge tank locomotive for the Pöltschach-Gonobitz and Wieselsdorf-Stainz lines.

conditions as regards curves and gradients than the lines hitherto considered, as the minimum radius is 73 metres (3·65 chains) on one of the lines and over 100 to 150 metres (5 to 7 1/2 chains) on the others; the gradients are also very moderate and the steepest is only 19 per mil. These conditions of the line exercise a material influence on the design of the more powerful locomotives, so that no proper comparison between them and the locomotives previously described can be made.

Among them we may specially mention
6a) the 1 D 2 tank locomotive of the Bengal-Nagpur Railway, which can take an unusual quantity of stores; its power, according to the standards laid down in the introduction, may be estimated at 290 horse-power. In addition, there is
6b) the 1 D 1 locomotive with separate tender, of the same railway, which gives 410 horse-power, or 5·4 horse-power per centimetre (13·5 horse-power per inch) of gauge; this very good ratio is only exceeded by one American locomotive. The two types are also distinguished by having a great adhesive weight, one being just over and the other just under 28 tons (27·5 English tons); in this respect they also differ materially from the European types. Finally there is a 2 C 1 locomotive
6c) with separate tender, giving 345 horse-power.

8) The North Western State Railway describes, besides a number of locomotives of weaker type, three similar types
b) of 1 C 1 tank locomotives with an adhesive weight of 25·7 tons (25·3 English tons) and giving 275 horse-power.

All of these locomotives are powerful and there is no complicated design in connection with the driving wheels, only the old and simple designs being used; these locomotives are accordingly no doubt distinguished by a low cost of maintenance. One peculiarity is that in spite of the favourable line conditions and in spite of the long flexible wheelbases, a low maximum speed is specified, amounting in all cases to 24·1 kilometres (15 miles) per hour with the solitary exception of the type on the Bombay, Baroda and 9)
Central India Railway, in which case it is 32·2 kilometres (20·0 miles) per hour.

D. — *Railways with a gauge of 785 millimetres (2 ft. 6 29/32 in.).*

Particulars about locomotives of this 1)
gauge have been sent only by the Kattowitz Directorate of the Prussian-Hessian State Railway.

Apart from a series of C tank locomo- a)
tives of moderate power of simple design, of which thirty-nine were built during the years 1876-1901, three noteworthy types are described which are used under rather difficult conditions, the minimum radius being 40 or 35 metres (2 or 1 3/4 chains) and the steepest gradient 40 per mil.

A tank locomotive, of which four were b)
built during the years 1898-1901, is of the C + B type; it has two cylinders; three driving axles are in the main frame and two driving axles are in a bogie, on the Hagans system; the adhesive weight is 27·15 tons (26·72 English tons) the heaviest axle-load being only 5·49 tons (5·40 English tons); the total wheelbase (all axles being driving axles) is large, namely 4,650 millimetres (15 ft. 3 in.), and this corresponds to 5·83 tons per

metre (1·75 English tons per foot) of wheel-base.

On the steepest gradient of 40 per mil this locomotive gives an available draw-

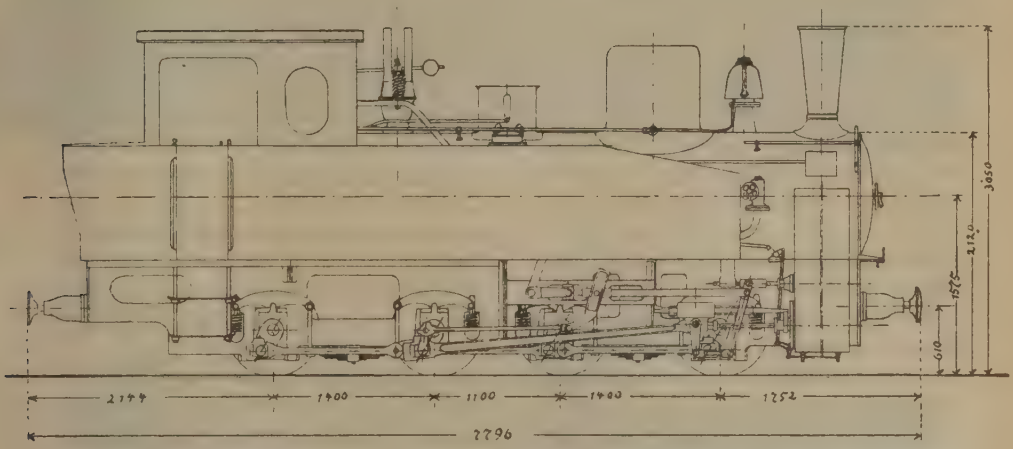

Fig. 11. — Prussian State Railway. Kattowitz Directorate. — D tank locomotive, Klien-Lindner design, used on the Upper Silesia narrow-gauge lines 785 millimetres (2 ft. 6 $^{29}/_{32}$ in.).

bar pull of 3,105 kilograms (6,845 lb.) and develops 220 horse-power, or 8·1 horse-power per ton (8·11 horse-power per English ton) of locomotive.

c and d) Next to these, there are a number of D locomotives (fig. 11) built during the years 1902-1907, which are of two very similar types. The leading and the trailing pairs of wheel have radial play, on the Klien-Lindner system, to allow for curves. These locomotives have shorter wheelbases, greater axle-loads and greater tractive power than the class last described; they work at higher pressure and give about the same power. Owing to the greater simplicity of the transmission of the drive to the axles with radial play, this design is probably preferable in many cases.

E. — *Railways with a gauge of 890 or 891 millimetres (2 ft. 11 $^{3}/_{64}$ in. or 2 ft. 11 $^{3}/_{32}$ in.).*

(Figs. 12 to 17.)

Answers to the list of questions were received from two administrations in Sweden; the answers include one hundred and four locomotives, of ten different types. The narrow-gauge lines in this country have become developed in a peculiar way, for what has been said about the 762 millimetres (2 ft. 6 in.) gauge in India, applies to a still greater extent in the case of these lines, which have by no means the usual character of narrow-gauge lines, but have very favourable conditions both as regards curves and gradients. The minimum radii of the curves

on the open line vary between 148 and 300 metres (between 7·4 and 15 chains), and at switches between 119 and 150 metres (between 5·95 and 7·5 chains); the steepest gradients are between 16 and 27·6 per mil. With such favourable conditions, these lines are better able to cope with a busy traffic than any of the other narrow-gauge lines. These very favourable conditions have made it possible for locomotive designers to increase the size both of the rigid and of the total wheelbase; and a glance at a drawing or illustration of such a locomotive shows that this type is quite different from those hitherto considered; it seems more like a smaller specimen of a standard-gauge locomotive.

The individual axle-loads are not much greater than the maximums hitherto considered, but are all large, and vary between 6·1 and 7·05 tons (between 6 and 6·94 English tons). The adhesive weights do not exceed those hitherto considered, but are mostly near the upper limit; the power is by no means as great as that of the most powerful Indian locomotives, but is near the upper limit of all the others. On the other hand, the speed has been developed to such a degree, that these locomotives not only surpass all those hitherto considered, but also many locomotives used on wider gauges. Except in the case of three types, the maximum speeds are fixed at from 50 to even 65 kilometres (31 to even 40·4 miles) per hour, and the latter makes it possible to have an accelerated passenger-train service on narrowgauge lines. Among them we may
1a) mention a 1 C compound locomotive with separate tender, of the Swedish State Railway; this has a rigid wheelbase of 3,400 millimetres (11 ft. 1 7/8 in.) and a total wheelbase of 5,400 millimetres (17 ft. 8 5/8 in.) and gives 270 horse-power or 11·15 horse-power per ton (11·17 horse-power per English ton) of locomotive; it runs at a speed of 60 kilometres (37·3 miles) per hour.

Then there is a 1 C 1 tank locomotive f) with a rigid wheelbase of 3,000 millimetres (9 ft. 10 in.) and a total wheelbase of 6,275 millimetres (20 ft. 7 in.). It uses superheated steam and gives 280 horse-power, or 8·37 horse-power per ton (8·39 horse-power per English ton) locomotive. The speed authorized is 50 kilometres (31·0 miles) per hour.

The Stockholm-Rimbo Railway des- 2a) cribes three types of which one is a compound 1 C locomotive with separate tender, having a rigid wheelbase of 3,400 millimetres (11 ft. 1 7/8 in.) and a total wheelbase of 5,400 millimetres (17 ft. 8 5/8 in.). This is the most powerful locomotive of this gauge; it gives 275 horse-power or 11·37 horse-power per ton (11·40 horse-power per English ton) of locomotive (tender excluded), and this is the gratest power per unit of weight given by any locomotive with separate tender. Should increasing traffic make it necessary, there will be no difficulty in designing much more powerful locomotives for lines of this character, without having to go in for too much complication.

F. — *Railways having a gauge of 914 millimetres (3 feet).*

(Figs. 18 and 19.)

Four of the railways administrations in the United States have sent descriptions of seventeen classes of locomotives; ele

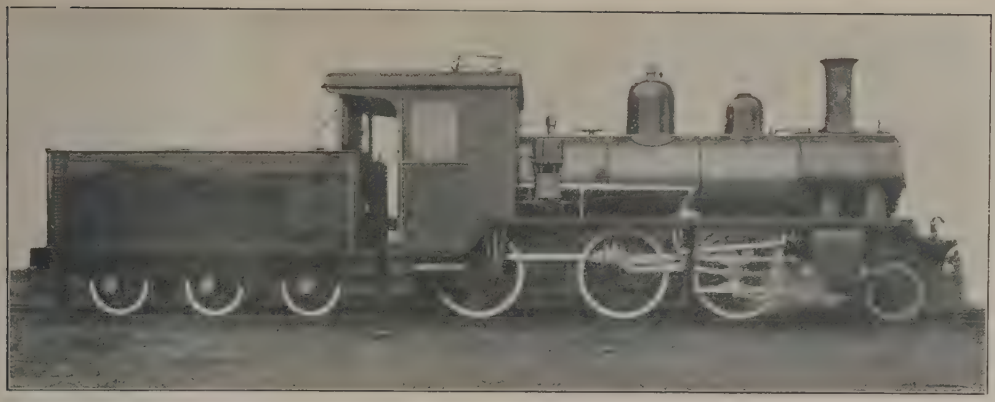

Fig. 12. — Swedish State Railway. — Stockholm-Rimbo line. — Gauge 890 millimetres (2 ft. 11 $^{3}/_{64}$ in.).

Fig. 13. — Swedish State Railway. — Dala-Ockelbo-Norrsundet line. — Gauge 890 millimetres (2 ft. 11 $^{3}/_{64}$ in.).

Fig. 14. — Swedish State Railway. — Hvetlanda-Säfsjö line. — Gauge 890 millimetres (2 ft. 11 $^{3}/_{64}$ in.).

Fig. 15. — Swedish State Railway. — Kinnekulle-Sidköpping-Häkantorp line.
Gauge 890 millimetres (2 ft. 11 $^{3}/_{64}$ in.).

Fig. 16. — Swedish State Railway. — Uddevalla-Lelaugen line. — Gauge 890 millimetres (2 ft. 11 $^{3}/_{64}$ in.).

Fig. 17. — Swedish State Railway. — Västergötland-Göteborg line. — Gauge 890 millimetres (2 ft. 11 $^{3}/_{64}$ in.).

Fig. 18. — Pennsylvania Lines West of Pittsburgh. — 1 C goods locomotive. Mogul type.
Gauge 914 millimetres (3 feet).

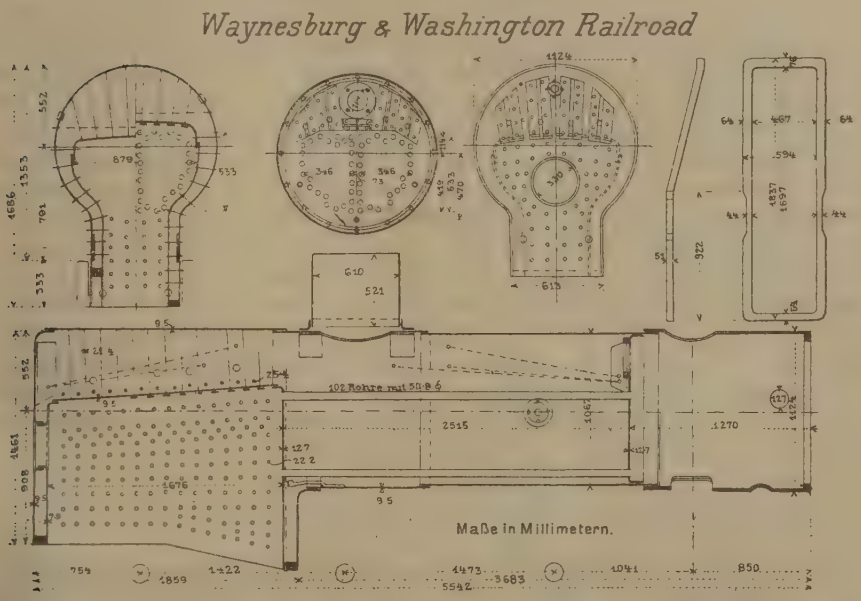

Fig. 19. — Pennsylvania Lines West of Pittsburgh. — Details of boiler of locomotive shown in fig. 18.
Gauge 914 millimetres (3 feet).

Explanation of German terms : 102 Rohre mit 50·8 ϕ = 102 tubes, diameter 50·8 millimetres (2 inches).
Masse in Millimetern = Dimensions in millimetres.

ven types which show material variations, are given in the appendix, while no particulars are given of two lots of three each, as they are very similar to two others. All these locomotives are used on lines where the conditions as to curves and gradients are very difficult.

The minimum radii of the curves on these lines, in so far as they are given in the answers, vary between 47 and 70 metres (between 2·35 and 3 $^1/_2$ chains) on the open line, and the steepest gradients between 25·6 and 82·5 per mil. In spite of these very unfavourable conditions, and without using any unusual design for the driving wheels, considerable power is obtained, in fact four similar types are among the most powerful locomotives about which we have any particulars. This is due in the first place to the magnitude of the individual axle-loads, which all exceed 6·5 tons (6·4 English tons) and in one case attain 12 tons (11·81 English tons). The fixed wheelbases used are much longer than those used in Europe for similar curves. All of them are locomotives with separate tender, which holds a large quantity of stores; and in some cases very high speeds, up to 64 kilometres (39·7 miles) per hour, are considered admissible.

2) The most powerful types are those described by the Chicago, Burlington and Quincy Railroad; they are used for lines with curves having minimum radii of 47 metres (2·35 chains) and steepest gradients of 82·5 per mil. One class of 1 C
a) locomotives with separate tender was built in 1882; there are four very similar types. The adhesive weight is 26·76 tons (26·34 English tons), and the maximum axle-load is 9 tons (8·85 English tons). The large rigid wheelbase of 3,206 millimetres (10 ft. 6 $^1/_4$ in.) is only able to run round the sharp curves, because each of the coupled axles has a lateral play of 4 millimetres ($^5/_{32}$ inch). These locomotives give 275 horse-power, and at the time when they were built this was without doubt much in advance of all other narrow-gauge locomotives.

Four newer types of 1 D locomotives *b*) built in 1900 occupy as regards power the second position among all the locomotives reported. The great adhesive weight of 44·62 tons (43·91 English tons) is combined with a more moderate but still large rigid wheelbase of 3,023 millimetres (9 ft. 11 in.), which is enabled to run round curves in the same way as in the case of the older type, by allowing the axles a little lateral play. The maximum axle-load is 12 tons (11·8 English tons). The total weight of 49·61 tons (48·82 English tons) is carried on at otal whellbase of 5,182 millimetres (17 feet), so that the load per metre of wheelbase amounts to 9·57 tons (2·87 English tons per foot).

The locomotive gives 500 horse-power, or 5·47 horse-power per centimetre of gauge or 10·05 horse-power per ton (14 horse-power per inch or 10·21 horse-power per English ton) of locomotive (tender excluded), and both the road and the roadbed are subjected to considerable fatigue for the purpose.

G. — *Railway having a gauge of 950 millimetres (3 ft. 1 $^3/_8$ in.)*

This class includes one type of locomotive of the Italian State Railway; twelve of these locomotives were built in 1909. The conditions as to curves and gradients are rather difficult; the sharpest curve has

a radius of 100 metres (5 chains) and the steepest gradient is 25 per mil. The axle-load admitted, namely 12·5 tons (12·3 English tons) is the highest reported. This condition makes it possible to design a very powerful type. The adhesive weight of 47·9 tons (47·14 English tons) is distributed over a wheelbase of 3,750 millimetres (12 ft. 3 5/8 in.); the maximum average load per metre of wheelbase is 12·77 tons (12·56 English tons). Under these conditions, assuming the coefficient of adhesion to be 1/6, the available drawbar pull on the steepest gradient is 6,200 kilograms (13,668 lb.). The heating surface of the boiler exceeds 105 square metres (1,130 square feet) and the maximum working pressure is 14 atmospheres (206 lb. per square inch); this makes it possible to develop 430 horse-power or 8·98 horse-power per ton (8·83 horse-power per English ton) of locomotive, so that this locomotives is included among those of economical design.

H. — *Railways having a gauge of 1,000 millimetres (3 ft. 3 3/8 in.).*

As many as seventeen administrations in Germany, the Argentine, Spain, France, Italy, Luxemburg, Portugal, Russia and Switzerland, sent answers about such lines, and as particulars of seventeen different types of locomotives were given, we may conclude that this gauge is the one most in favour. The characters of these lines vary widely; there are minimum radii of 21 and of 450 metres (1·05 and 22 1/2 chains), and the gradients also vary between 8 and 58·82 per mil, so that no general representation of the conditions is possible. Accordingly the designs of the locomotives also vary within wide limits, and besides typically narrow-gauge light specimens we also find very heavy types. Most of the German lines are of a difficult character, and for these tank locomotives are exclusively used; we may draw attention to the following :

1b) One type of the Alsace-Lorraine State Railway. This is a D locomotive used on curves with a minimum radius of 50 metres (2 1/2 chains) and has the large adhesive weight of 28·65 tons (28·19 English tons); the trailing pair of wheels, in a Bissel truck, is driven by a loose axle, and in this way the large wheelbase (coupled wheels only) of 3,400 millimetres (11 ft. 2 in.) is obtained.

2a) The Bavarian State Railway describes a 1 C type for a line on which the sharpest curves have a radius of only 21 metres (1·05 chains), and in spite of these difficult conditions it obtains a similar adhesive weight by having a greater individual axle-load, namely 8·3 tons (8·2 English tons).

3c) The Erfurt Directorate of the Prussian-Hessian State Railway describes, among others, (fig. 20 to 22) a D tank locomotive which is designed for curves having a radius of 40 metres (2 chains) and has an adhesive weight of 29·67 tons (29·20 English tons), the maximum axle-load being only 7·6 tons (7·48 English tons). This result is obtained by having for the fourth pair of coupled wheels an adjustable hollow-axle; the total wheelbase (coupled wheels only) is 3,300 millimetres (10 ft. 9 15/16 in.) and the load per metre of wheelbase is 9·0 tons (2·70 English tons per foot).

4) The Saxon State Railway has a class of B + B compound locomotives (fig. 23) with four cylinders, on the Fairlie sys-

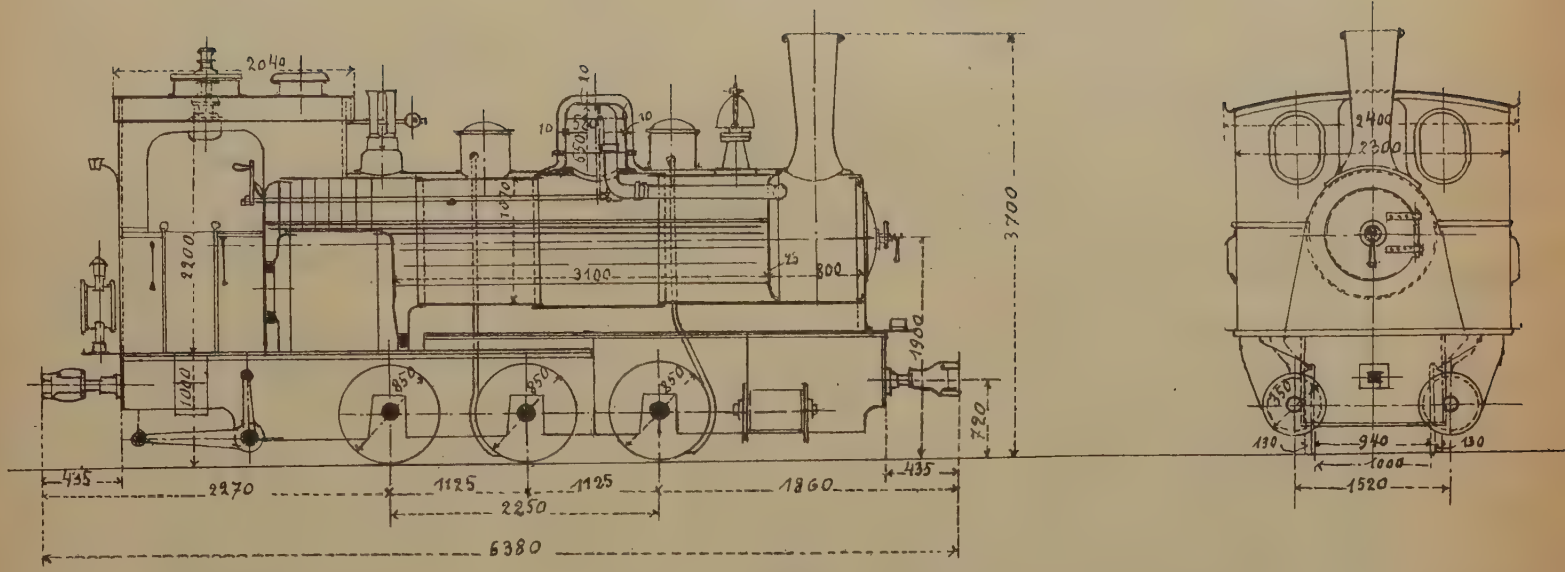

Fig. 20. — Prussian State Railway, Erfurt Directorate.

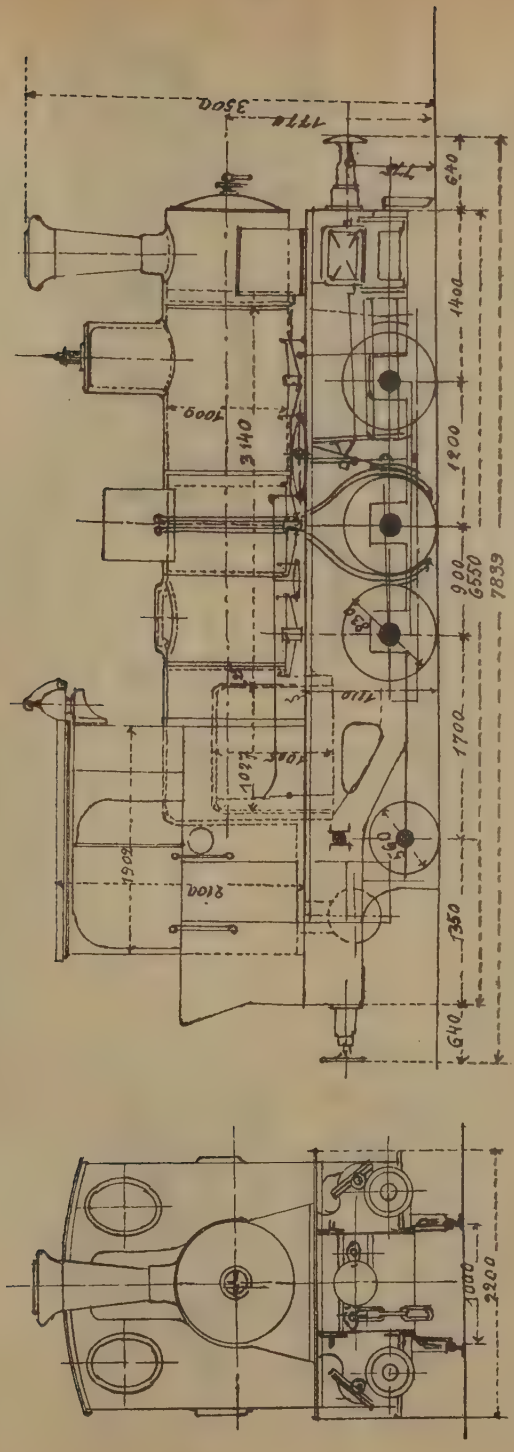

Fig. 21. — Prussian State Railway, Erfurt Directorate.

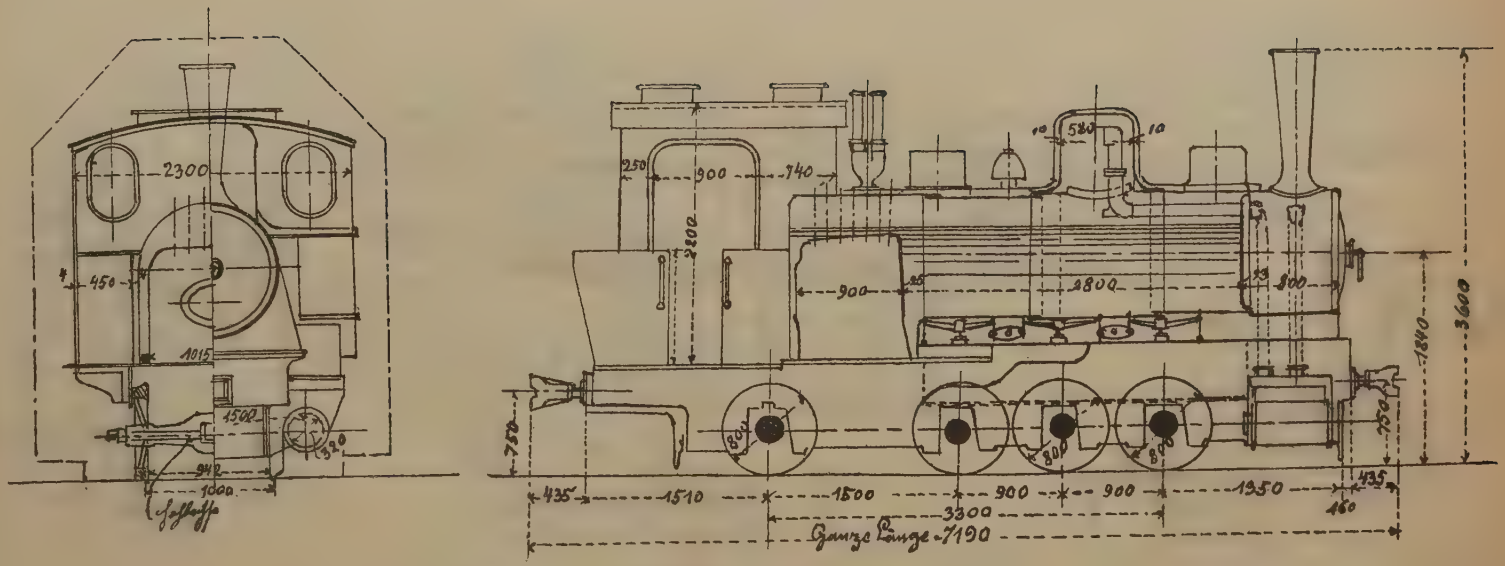

Fig. 22. — Prussian State Railway, Erfurt Directorate.

Explanation of German terms : Ganze Länge = Total Length.

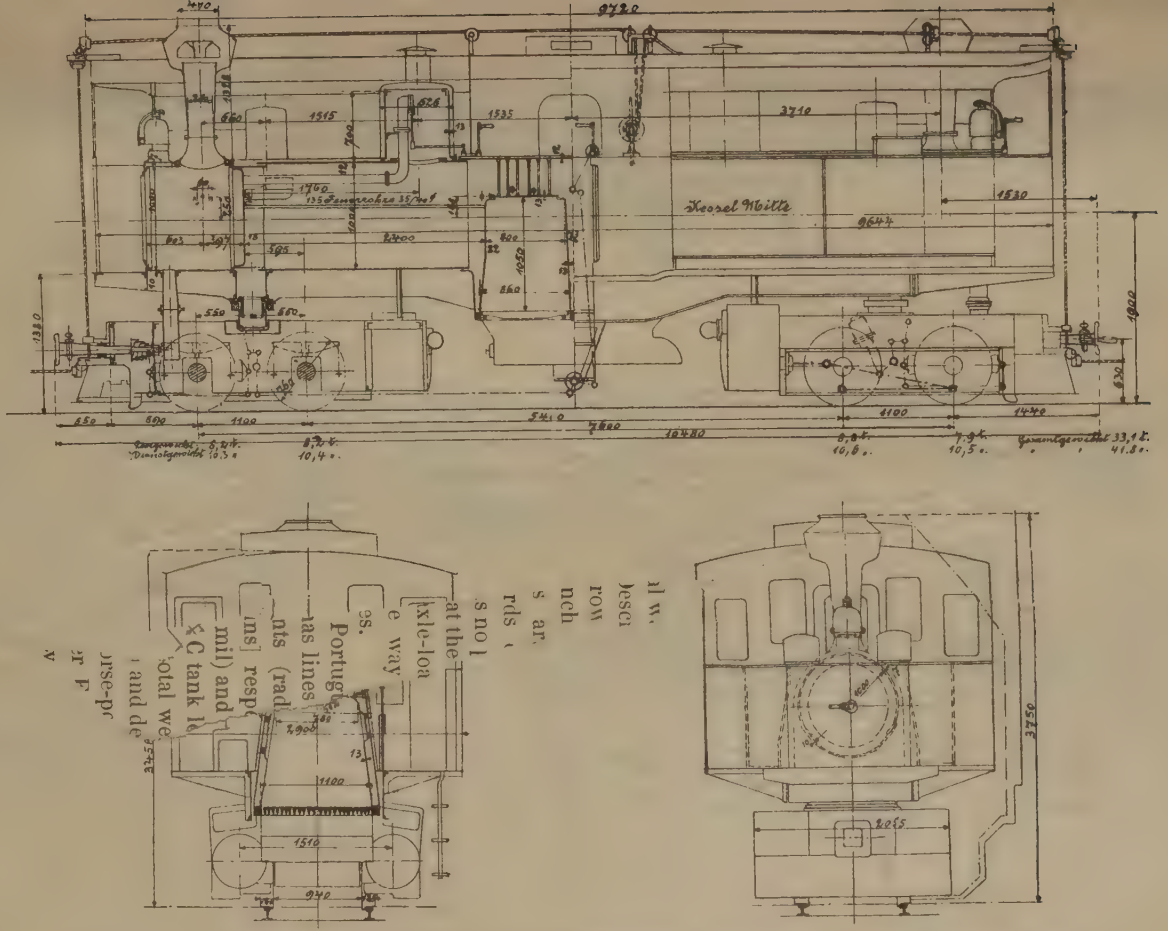

Fig. 23. — Saxon State Railway. — B + B compound tank locomotive, Fairlie design. — Gauge 1 metre (3 ft. 3 3/8 in.).

Explanation of German terms : Feuerrohre = Smoke tubes. — Kesselmitte = Centre line of boiler. — Leergewicht = Weight, empty. Dienstgewicht = Weight in working order. — Gesamtgewicht = Total weight.

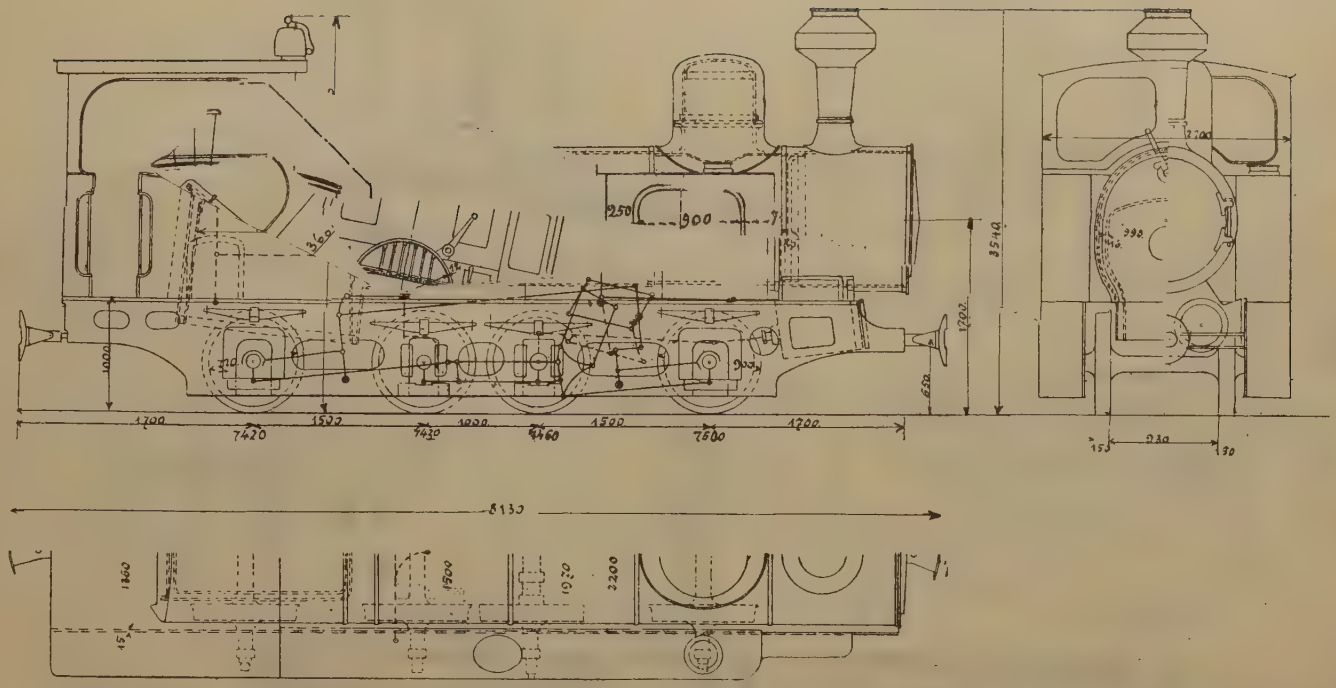

Fig. 24. — Wurtemberg State Railway. — D tank locomotive, type Ts_4, gauge 1 metre (3 ft. 3 3/8 in.). Used on the Nagold-Altensteig line.

tem, designed for curves having a minimum radius of 30 metres (1 1/2 chains) on the open line and of 25 metres (1 1/4 chains) at swiches. This locomotive has an adhesive weight of 41·8 tons (41.14 English tons), and the high maximum axle-load of 10·6 tons (10·4 English tons). The weight is well distributed by the wheelbase of 7,600 millimetres (24 ft. 11 1/4 in.), so that the load only amounts to 5·5 tons per metre (1·65 English tons per foot) of wheelbase. On the steepest gradient of 25 per mil, the available drawbar pull, on the same assumptions as made in the previous cases, is 5,460 kilograms (12,037 lb.).

The locomotive gives 395 horse-power, or 9·43 horse-power per ton (9·47 horse-power per English ton) of locomotive. Taking into consideration the sharp curves on which this locomotive is used, and its dimensions, it must be described as one of the most powerful types of its kind.

6) The Argentine Northern Railway has very favourable line conditions; the minimum radius is 450 metres (22 1/2 chains) on the open line and 180 metres (9 chains) at switches, the steepest gradient being 12 per mil. It accordingly has more of the character of a line for long-distance traffic. The locomotives, which all have a separate tender, could be made very powerful without adopting any unusual design.

6a) One type is a 2 C locomotive with an adhesive weight of 32·98 tons (32·46 English tons) and a maximum axle-load of 11·5 tons (11·3 English tons). Wood is used for firing; a locomotive of similar dimensions but arranged for coal firing would develop about 460 horse-power.

8) The Orleans Railway describes, besides a number of lighter types of older construction, a B + B compound locomotive (fig. 25) with four cylinders, on the Mallet system, for use on a line having curves with a minimum radius of 100 metres (5 chains) and steepest gradients of 30 per mil. This is very similar, as regards power and tractive effort, to the type of the same group described under 4); but it has a small total wheelbase, although the wheelbase of each of the driving bogies is larger.

10) The St. Quentin-Guise and Aisne Department Railway, for a line with steepest curves having a radius of 40 metres (2 chains) and steepest gradients of 44 per mil, has had built three light B2 automotors, with vertical boiler, having a total weight of 24 tons (23.6 English tons). b)

Descriptions of the locomotives of other narrow-gauge lines have also been sent by French railway administrations. These lines are either favourably placed as regards curves and gradients, or there seems no particular need for high powers, so that the locomotives could be designed, the axle-loads being rather high, in a simple way without using complicated engines.

13) The Portuguese National Railway Company has lines with favourable curves and gradients (radii 150-100 metres [7 1/2-5 chains] respectively and gradients of 18 per mil) and besides a lighter type also b) uses a 1 C tank locomotive which has the moderate total weight of 32 tons (31·5 English tons) and develops 325 horse-power, or 10·2 horse-power per ton (10·22 horse-power per English ton) of locomotive; this shows a proper economy in the design.

14) The Riazan-Ural Railway has no difficul-

ties to overcome on its line. The locomotives have separate tenders, are of simple design and of medium size; as naphtha is used for firing, much more power is obtained with heating surfaces of moderate sizes, than would be possible with coal.

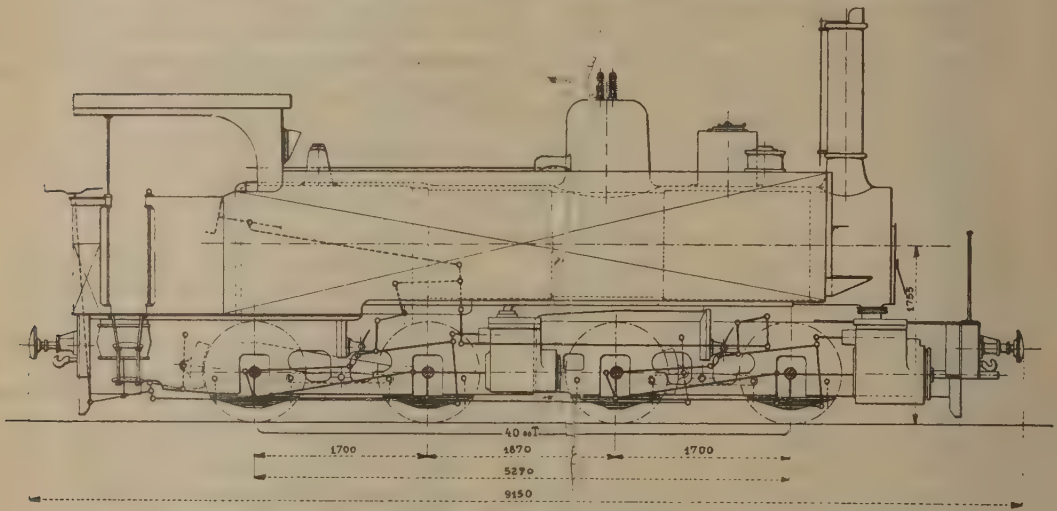

Fig. 25. — Orleans Railway. — Compound tank locomotive, Mallet system. Used on the Corrèze line.

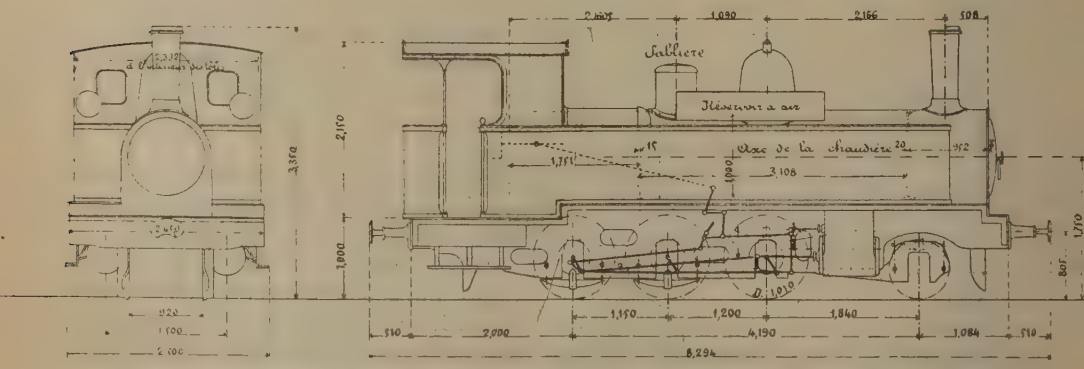

Fig. 26. — Paris-Lyons-Mediterranean Railway. — 1 C tank locomotive used on the Orange-Buis-les-Baronnies line.

Explanation of French terms : A l'intérieur des tôles = Inside the plates.
Sablière = Sanding apparatus. — Axe de la chaudière = Centre line of boiler. — Réservoir à air = Air reservoir.

16) The Rhetian Railway (Switzerland) sends particulars of a 1 D locomotive with separate tender (fig. 29) for a line on which the sharpest curves have a radius of 100

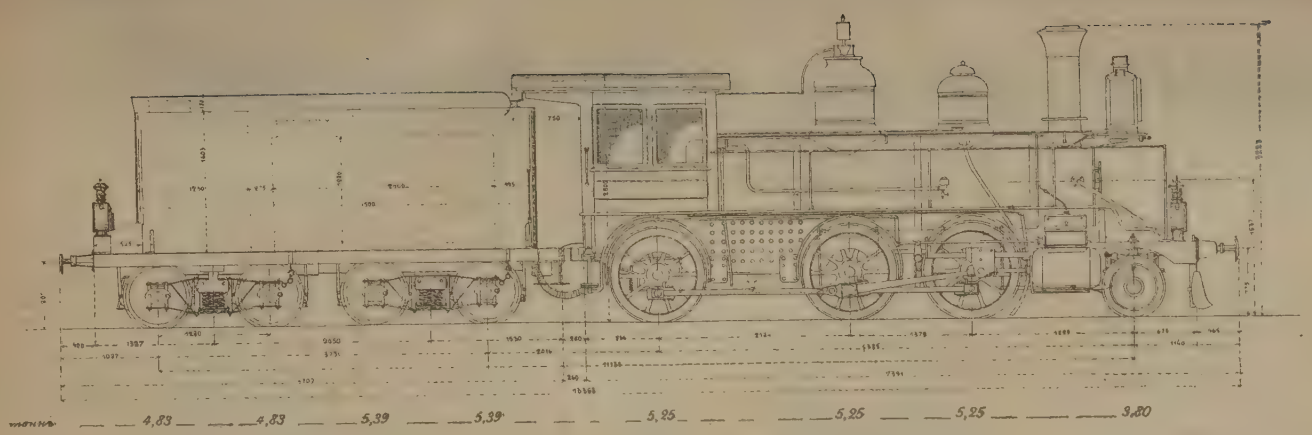

Fig. 27. — Riazan-Ural Railway.

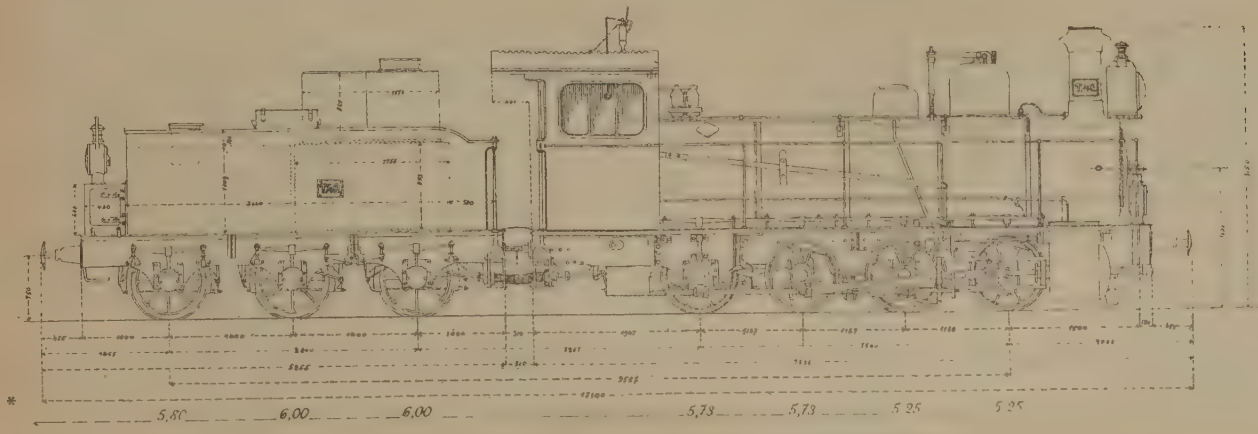

Fig. 28. — Riazan-Ural Railway.

metres (5 chains) on the open line and of 90 metres (4 $^1/_2$ chains) at switches, and the steepest gradient is 45 per mil. The maximum axle-load is rather high with this type, namely 10·62 tons (10·45 English tons); the adhesive weight is 41·6 tons (40·9 English tons) and the total weight is 46·98 tons (46·23 English tons), which are distributed by wheelbases of 4,050 and 6,100 millimetres (13 ft. 3 $^1/_2$ in. and 20 feet) respectively, and give the moderately-high average load of 7·7 tons per metre (2·31 English tons per foot) of wheelbase. The steam is superheated and used at a medium pressure; the greatest amount of power is obtained, namely 520 horse-power, or 11·1 horse-power per ton (11·12 horse-power per English ton) of locomotives tender excluded; this ratio is also a very good one.

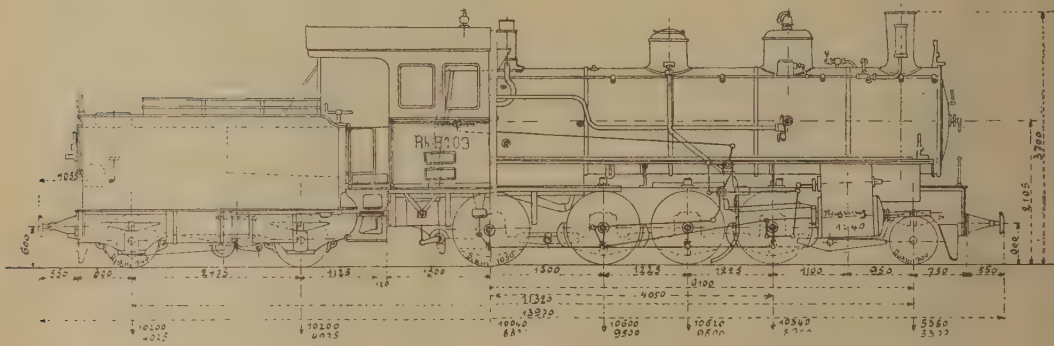

Fig. 29. — Rhetian Railway. — 1 D two-cylinder superheated-steam locomotive.

J. — *Railways having a gauge of 1,067 millimetres (3 ft. 6 in.).*

The curves on the line having this gauge are in most cases very easy, and the gradients, except in one case, also present no difficulties; the locomotives built for operating the traffic on these lines differ but little, as far as dimensions and power are concerned, from the average of the narrow-gauge locomotives already considered, except as regards the high admissible speeds, which amount to from 56 to
2) 60 kilometres (34·8 to 37·2 miles) on the Norwegian State Railway and to 50 kilo-
3) metres (31 miles) per hour on the Moscow-Vindau-Rybinsk Railway and on the Swiss Federal Railway; these are among the
4) highest speeds reported. Quite apart from the question of the dimensions and the powers, we must not leave out of consideration the large number of locomotives (561) which the Belgian National Suburban
1) Railway Company has had built of only two types, so obtaining all the advantages of work on a large scale both as regards the operation of the traffic and the maintenance of the locomotives, in a way to which no other administration has even approximated. The high adhesive weight of 29 tons (28 5 English tons) when there are curves with a radius of 25 metres (1 $^1/_4$ chains) is also noteworthy and is made possible by the axle-load of 9·7 tons (9·5 English tons).

3. — Chief properties of the locomotives.

A considerable number of particulars and figures have been given of the locomotives which in consequence of any special feature were described in the preceding sections; in order to facilitate a general view of the subject, we give a table containing a selection of the more powerful types of all gauges, which includes those locomotives which are specially remarkable from the following points of view :

a) Absolute horse-power;
b) Horse-power per centimetre of gauge;
c) Horse-power per ton of locomotive;
d) Adhesive weight;
e) Individual axle-loads;
f) Ratio of adhesive weight to radius of curves which are on the line concerned.

In each case the three highest values are underlined :

If we now consider the measures which have been taken in order to improve the limited quality coefficients of the older designs, we can make the following general remarks :

A. — *The power of the locomotives was increased :*

1° By increasing the working pressure;
2° By superheating the steam;
3° By the introduction of compounding.

Indirectly this also incluces the devices enabling the axles to adjust themselves to curves, in the case of those wheelbases which correspond to the weight of the engine required for a given power and to the admissible loads on the road-bed. The devices however only give difficulty if the adjustable axles are to be driving axles, and tend to increase the adhesive weight.

a) The working pressures which are used vary between 8 and 14 metric atmospheres (between 117·6 and 206 lb. per square inch) and their distribution as regards types of locomotives, leaving gauge out of consideration, is shown in the table given below. We have left the pressure in the vertical boiler of one tractor, of 18 to 25 atmospheres (264·7 to 368 lb. per square inch), out of consideration, and only take the figures for ordinary locomotive boilers :

Up to

8, 9, 10, 11, 12, 13, 14 atmospheres (117·6, 132·4, 147, 161·8, 176·5, 191, 206 lb. per square inch).

Were used on

3, 1, 18, 18, 41, 15, 4 types of locomotives.

The pressure of over 12 and up to 13 atmospheres (over 176·5 and up to 191 lb. per square inch) is already in use on the types in question since 1896; they include :

Two types of the Prussian-Hessian State Railway (gauge 785 millimetres [2 ft. 6 $^{29}/_{32}$ in.], items 1*c* and *d*);

Three types of the Austrian State Railway (gauge 760 millimetres [2 ft. 5 $^{29}/_{32}$ in.], items 1*a* to *c*);

Four types in the United States of America (gauge 914 millimetres [3 feet], item 2 *b*);

Three types in India (gauge 762 millimetres [2 ft. 6 in.], item 8*b*);

One type of the Norwegian State Rail-

Comparative table of

Gauge, in milli metres.	Index number.			NAME OF RAILWAY.	Radius of sharpest curve, in metres.	Arrangement of axles.	Weight adhesive, in tons.	Weight to in tons.
610	A	2	...	Natal Government Railways	61	T. L. 2 C 1	17·42	26·42
750	B	1	*b*	Saxon State Railway	50/43	T. L. -D-	28·7	
	B	3	..	Fayoum Light Railway Company	40/30	T. L. 1 C 1	20·36	28·6
760	C	1	*c*	Austrian State Railway	60	T. L. -C 2	17·9	26·5
762	C	6	*b*	Bengal-Nagpur Railway	117/86	L. s. T. 1 D 1	28·44	39·42
785	D	1	*b*	Prussian-Hessian State Railway. Kattowitz Directorate	40/35	T. L. C + B	27·15	
	D	1	*d*		40/35	T. L. -D-	27·34	
890	E	1	*f*	Swedish State Railway	300/150	T. L. 1 C 1	20·95	33·5
914	F	2	*b*	Chicago, Burlington & Quincy Railroad	47	L. s. T. 1 D-	44·62	49·61
950	G	1	...	Italish State Railway	100	T. L. -D-	47·9	
1,000	H	2	*a*	Bavarian State Railway	21	T. L. 1 C-	22·8	26·7
	H	3	*c*	Erfurt Directorate	40	T. L. -D-	29·67	
	H	4	...	Saxon State Railway	30/25	T. L. B + B	41·8	
	H	6	*a*	Argentine Northern Railway	450/180	L. s. T. 2 C-	32·98	40·98
	H	8	c_2	Orleans Railway	100	T. L. B + B	40	
	H	16	..	Rhetian Railway	100/90	L. s. T. 1 D-	41·6	46·98
1,067	I	1	...	Belgian National Suburban Railway Company	25	T. L. -C-	29·0	
	I	4	...	Swedish State Railway	300/150	L. s. T. 1 C-	22·745	26·385

T. L. = Tank-locomotive; L. s. T. = Locomotive separate tender.

rful types of all gauges.

ximum e-load, tons.	Load per metre of wheelbase, in tons.	Ratio of adhesive weight to radius, of curves, in tons per metre.	Horse-power			*Remarks.*
			absolute.	per centimetre of gauge.	per ton of locomotive tender included.	
5·815	4·88	...	...	...	...	
7·3	7·37	0·668	250	3·33	8·7	Compound Klien-Lindner system
7·12	...	0·678	...	...	..	
6·0	5·5	...	280	3·68	10.57	Compound.
7·11	5·68	...	410	5·4	10·4 (6·95)	
5 49	5 83	...	220	2·81	8·1	Hagans system.
7·01	...	0·782	...	...	...	Klien-Lindner system.
7·0	5·34	...	280	3 15	8·37	Superheated steam.
2·0	9·57	0·95	500	6·47	10·05 (?)	
2·5	12·77	...	430	4·53	8 98	14 Atmospheres.
8 3	...	1·084	...	...		
7·6	...	0·742	...	...	...	Hollow axle.
0·6	5.5	1 67	395	3·95	9·43	Fairlie type.
1·5	6·6	...	460	4·6	11·25 (6·23)	
0·2	7·58	..	370	3·7	9·25	Mallet type, 14 atmospheres.
0·62	7·7	...	520	5·2	11·1 (?)	Superheated steam.
...	9·7	1·16	...	...	..	
7·69	5·5	...	2·5	2·2	8·92 5·74	

way (gauge 1,067 millimetres [3 ft. 6 in.], item 2*c*);

Two types of the Stockholm-Rimbo Railway, in Sweden (gauge 891 millimetres [2 ft. 11 $^{3}/_{32}$ in.], item 2*a*).

The pressure of over 13 and up to 14 atmospheres (over 191 and up to 206 lb. per square inch) is in use on only four types, since 1901; they include :

Two types of the Saxon State Railway (gauge 750 millimetres [2 ft. 5 $^{1}/_{2}$ in.], item 1*b*);

One type of the Orleans Railway (gauge 1,000 millimetres [3 ft. 3 $^{3}/_{8}$ in.], type $8c_2$);

One type of the Italian State Railway (gauge 950 millimetres [3 ft. 1 $^{3}/_{8}$ in.]).

This very productive measure for increasing the power, which requires much less than a proportionate increase in the weight of the boilers, could be applied all the more readily in the case of narrow-gauge locomotives, as the increase of temperature corresponding to an increase of pressure produces, in consequence of the smaller dimensions of the fire-boxes, a smaller expansion of the latter as compared with the outer shell than in the case of large fire-boxes. Consequently, the stays and their connexions with the plates are subjected to smaller bending stresses than in the case of large fire-boxes, and accordingly they resist better.

b) As regards superheating of the steam, much fewer data are available. There are six types of such locomotives, namely :

One type of the Bavarian State Railway, working pressure 12 atmospheres (176·5 lb. per square inch) (gauge 1,000 millimetres [3 ft. 3 $^{3}/_{8}$ in.] item 2*a*);

Three types of the Swedish State Railway, working pressure 11 atmospheres (161·8 lb. per square inch) (gauge 890 millimetres [2 ft. 11 $^{3}/_{64}$ in.], items 1*f* and 1*g*), and 10 atmospheres (147 lb. per square inch) (gauge 1,067 millimetres [3 ft. 6 in.], item 4);

One type of the Stockholm-Rimbo Railway, working pressure 11 atmospheres (161·8 lb. per square inch) (gauge 891 millimetres [2 ft. 11 $^{3}/_{32}$ in.], item 2*c*);

One type of the Rhetian Railway, working pressure 12 atmospheres (176·5 lb. per square inch) (gauge 1,000 millimetres [3 ft. 3 $^{3}/_{8}$ in.], item 16).

The use of these locomotives dates back to 1906, and it is probable that the fuel economy which can be realized in this way was an important factor in the selection of this system. As far as available information shows, the steam is superheated to 300° C. (572° Fahr.).

c) Compounding already came into use in 1892; fourteen types are described, five of them with four cylinders. They are used by the following administrations :

Three types of the Saxon State Railway, with four cylinders, working pressure 12 atmospheres (176·5 lb. per square inch) (gauge 750 millimetres [2 ft. 5 $^{1}/_{2}$ in.] item 1*a*), and 14 atmospheres (206 lb. per square inch) (item 1*b*); also with four cylinders, working pressure 14 atmospheres (206 lb. per square inch) (gauge 1,000 millimetres [3 ft. 3 $^{3}/_{8}$ in.], item 4);

One type of the Wurtemberg State Railway, with four cylinders, working pres-

sure 12 atmospheres (176·5 lb. per square inch) (gauge 750 millimetres [2 ft. 5 1/2 in.], item 2);

Two types of the Austrian State Railway, working pressure 13 atmospheres (191 lb. per square inch) (gauge 760 millimetres [2 ft. 5 15/16 in.], items 1*b* and 1*c*);

One type of the Bukovina Local Railway, working pressure 13 atmospheres (191 lb. per square inch) (gauge 760 millimetres [2 ft. 5 15/16 in.], item 2);

One type of the Arad-Csanad Railway, with two de Dion Bouton two-cylinder motors, working up to a pressure of 25 atmospheres (368 lb. per square inch) (gauge 760 millimetres [2 ft. 5 15/16 in.], item 4);

One type of the Orleans Railway, with four cylinders, working pressure 14 atmospheres (206 lb. per square inch) (gauge 1,000 millimetres [3 ft. 3 3/8 in.], item 8c_2);

Two types of the Norwegian State Railway, working pressure 12 atmospheres and 13 atmospheres (176·5 and 191 lb. per square inch) (gauge 1,067 millimetres [3 ft. 6 in.], items 2*a* and 2*c* respectively);

One type of the Riazan-Ural Railway, working pressure 11 atmospheres (161.8 lb. per square inch) (gauge 1,000 millimetres [3 ft. 3 3/8 in.], item 14*b*);

One type of the Swedish State Railway, working pressure 12·5 atmospheres (183·8 lb. per square inch) (gauge 890 millimetres [2 ft. 11 3/64 in.], item 1*a*);

One type of the Stockholm-Rimbo-Railway, working pressure 12·5 atmospheres (183 8 lb. per square inch) (gauge 891 millimetres [2 ft. 11 3/32 in.], item 2*a*).

The use of four cylinders is in all cases to be attributed to the use of two separate driving bogies.

B. — Finally, we have to consider the designs which result in an increase of the adhesive weight beyond that which is attainable when a rigid wheelbase is used.

These measures, leaving out of consideration play of the axle-boxes and the use of flangeless wheels on some of the coupled axles, can be divided into two chief classes :

1° The use of separate wheel pairs having radial play;

2° The use of bogies with the axles in a separate frame.

In both cases, the axles can be actuated either by purely mechanical transmission from one central complete steam engine, or each set of axles can have a separate engine. Particulars of altogether thirteen such designs are given, in which the object desired is attained more or less completely, though the designs are complicated ; there are eight types with single pairs of wheels and five types with separate motor bogies.

Leaving out of consideration a tractor [1] with two flexible axles, each with separate drive (gauge 760 millimetres [2 ft. 5 15/16 in.], item 4), which properly speaking is not to be included in this class, as in this case there is no question of obtaining a large adhesive weight, there are left seven types of tank locomotives, all of the D class, which utilize their whole weight as adhesive weight, and have axles which are radially adjustable.

These include eleven locomotives of

two types for a gauge of 1,000 millimetres (3 ft. 3 3/8 in.), namely :

One type (item 1*b*) of the Alsace-Lorraine State Railway;

One type (item 3*c*) of the Erfurt Directorate.

Both of these types have one such axle, while the following twenty-seven locomotives of five types each have two radially-adjustable axles, namely :

One type (gauge 750 millimetres [2 ft. 5 1/2 in.], item 1*b*) of the Saxon State Railway;

One type (gauge 760 millimetres [2 ft. 5 15/16 in.], item 5) of the Kaschau-Oderberg Railway;

One type (gauge 785 millimetres [2 ft. 6 29/32 in.], items 1*c* and 1*d*) of the Kattowitz Directorate;

One type (gauge 1,000 millimetres [3 ft. 3 3/8 in.], item 5) of the Wurtemberg State Railway.

The type last mentioned is of the Klose design, and was built 1891-1899; all the others were equipped with hollow axles on the Klien-Lindner system and were built 1901-1908.

These arrangements make it possible to obtain an adhesive weight of from 24 to nearly 30 tons (23·6 to nearly 29·5 English tons), with separate axle-loads not exceeding 6 to 7·6 tons (5·9 to 7·5 English tons), and to have wheelbases of 3,900 to 4,050 millimetres (12 ft. 9 9/16 in. to 13 ft. 3 1/2 in.), able to run over curves having a minimum radius of down to 40 metres (2 chains) on the open line and 35 metres (1 3/4 chains) at switches.

2) Among the designs with two motor bogies there is one type for a gauge of 785 millimetres (2 ft. 6 29/32 in.) (table 3, item 1*b*); this is on the Hagans system. The twin engine not only actuates the three fixed axles of the main frame, but the power is also transmitted, by means of a flexible transmission, to the two axles of the bogie. *a*)

Although the maximum axle-load of this locomotive is less than in the cases previously mentioned and only amounts to 5·5 tons (5·4 English tons), yet as there are five pairs of coupled wheels an adhesive weight of over 27 tons (26·5 English tons) is attained; the locomotive has a wheelbase of 4,650 millimetres (15 ft. 3 in.) and runs over curves having a minimum radius of 40 metres (2 chains) on the open line and of 35 metres (1 3/4 chains) at switches. These locomotives were acquired in the years 1898-1901.

By far the greatest adjustability of large wheelbases to sharp curves, is obtained by the use of two separate motor bogies, worked by two separate and complete engines. The administrations have sent particulars about four such types, namely: *b*)

Two types with two motor bogies of the Meyer and Fairlie design, capable of movement relatively to the main frame of the locomotive. *α*)

Forty-five locomotives of the first type have been built during 1892-1908 for a gauge of 750 millimetres (2 ft. 5 1/2 in.) (item 1*a*); three of the second were built in 1902, with their characteristic double-locomotive-boiler; these were all built for the Saxon State Railway.

Also two types with driving gear which consists of two fixed axles in the main frame, and of a complete motor bogie with a separate pair of cylinders, with two *β*)

axles in the bogie frame, and with the bogie centre placed near the middle of the centre line of the main frame, on the Mallet-Rimrott system.

Two types of B + B tank locomotives have been built on this system, one for the Wurtemberg State Railway (gauge 750 millimetres [2 ft. 5 1/2 in.], item 2) and one for the Orleans Railway (gauge 1,000 millimetres [3 ft. 3 3/8 in.], item 8), during the years 1899-1908.

Generally speaking, the adhesive weight obtained, for the same maximum axle-load, with these B + B locomotives is not greater than in the case of the D locomotives with adjustable coupled axles. On the other hand, the wheelbase can be made much longer, so that there is a better distribution of the load per metre of track and consequently it is easier with this design, than with that with separate adjustable axles, to obtain a greater adhesive weight without greater fatigue of the road-bed, if the track is strong enough. Actually maximum axle-loads of 5·94 to 10·6 tons (5·84 to 10·4 English tons) have been used, so that the resulting adhesive weight has been 27·15 tons (26·72 English tons) and upwards, and even attained 41·8 tons (41·1 English tons).

The wheelbases vary between 4,400 and 7,600 millimetres (between 14 ft. 5 in. and 24 ft. 11 in.), and they adjust themselves so well on curves, that the locomotives with the largest wheel-base are used on curves with a minimum radius of 30 metres (1 1/2 chains) on the open line and of 25 metres (1 1/4 chains) at switches; it is true that the shortest straight between reverse curves is 10 metres (32 ft. 10 in.), and the bogie centres are 6,500 millimetres (21 ft. 4 in.) apart; the two bogies can hence never be simultaneously on reverse curves.

This adjustability of the locomotives on sharp curves is illustrated in the comparative tables given by the ratios " Adhesive weight : curve radius "; it is obtained it is true at the cost of a very undesirable complication of the gear and of flexible steam-pipe connexions, which make maintenance difficult and expensive.

4. — General conclusions.

Having now examined in detail the different types of locomotives for narrow-gauge lines as regards the tractive effort and power developed, as well as the departures from old practice in order to improve the good qualities of the locomotives generally, we may assert with satisfaction not only that locomotive builders have always been able to meet the most severe demands made when new lines were schemed, but also that during the few tens of years that such lines have been operated, quality coefficients have been obtained which in many cases are twice as good as at first, and in some cases have improved even much more. This progress is all the more meritorious, because at the time when most of the narrow-gauge railways were built, the designs of standard-gauge locomotives had already reached a high standard of excellence, and when the construction of narrow-gauge locomotives was begun much better appliances were available than is generally the case with a new branch of industry.

Now, however satisfactory these considerations may be, we must not dwell any further on them, for the question of the latest locomotive types could not have as

its sole object the collection of data, although these are of considerable value for determining the capacity of such lines; but what formed its real object were the conclusions, to be drawn from the large total of the brain work which has been devoted in each individual case to the design of the different types, in the manufacturing countries of the whole world.

If in the first place we examine the influence exercised by the plan and profile of the line and the strength of the track on the development of the locomotives in order to ascertain how to obtain the most favourable combination of track and of operation, we come to the logical conclusion that in the case of new lines the track should be designed to suit those properties of the locomotives, which can be at present obtained with good designs, and which are required not only for the traffic immediately to be expected, but also for a traffic which has increased to a corresponding extent.

Starting from this point of view, we will in what follows enumerate, and give reasons for, those proposals which we should as a rule recommend, when it is a question of building new narrow-gauge lines for public traffic, to be operated by means of steam locomotives.

In the second place, we have to consider the measures which are advisable when acquiring new locomotives for existing lines, so as to obtain the power necessary for coping with the growing traffic, if the existing older types no longer suffice for this purpose.

Although these two points are not expressly laid down in the original wording of the question which is to be discussed, yet they necessarily follow from the examination of the subject, and indeed, what other body or corporation could be more able and more justified to recommend the adoption of certain principles, recognized as advantageous, than the Congress of the administrations who operate the existing lines and not only have acquired wide experience on the subject, but also have suffered from the consequences of difficulties in operation, which have in many cases resulted from small economies at the time of construction?

In the case of the separate points which are to be considered, we give in each case the position taken by the German *Verein* as laid down in " Grundzüge für den Bau und die Betriebseinrichtungen der Lokalbahnen nach den Beschlüssen der Vereins-Versammlung vom 3/5 September 1908 zu Amsterdam. Herausgegeben und verlegt von der geschäftsführenden Verwaltung des Vereins " (Berlin, 1 January 1909), and we will quote this, according to the established practice of the *Verein*, under the abbreviated designation *Grz*.

It is true that these principles are not of themselves applicable by the International Railway Congress, because the ground covered is much larger, and because it is by no means the case that all principles which may give excellent results in individual cases, can also be applied generally, particularly if the necessary preliminary conditions are not the same; they are however of such importance from the point of view of narrow-gauge railways, that on the one hand they could not be omitted without leaving lacunæ, and on the other they give many important points useful in the solution of the question generally.

The subject itself may be subdivided as follows :

A) *Track :*

1° Gauge;
2° Gradients;
3° Curves;
4° Wheel-loads.

B) *Locomotives :*

1° Increase of power :
  a) Working pressure;
  b) Superheating;
  c) Compounding.
2° Increase of adhesive weight.

A. — *Conclusions as regards track.*

1° The evolution of such a large number of different gauges, as described above, which in many cases only show very small differences, cannot be looked upon as an absolute necessity for the proper designing of the lines; and taking into consideration the resulting increase in the number of locomotive types and their consequent greater cost of construction and of maintenance, the selection of any other gauge than those already in existence must be looked upon as disadvantageous to the development of the narrow-gauge railway industry.

Taking into consideration that it has been possible to construct metre (3 ft. 3 3/8 in.) gauge locomotives which can run round as sharp curves as locomotives of smaller gauge, curves with a radius of as little as 30 metres (1 1/2 chains) and in one case even of 21 metres (1·05 chains), and also taking into consideration that it is possible to design, for this gauge, locomotives of considerable power, more capable of operating a growing traffic than would be the case with a narrower gauge, the gauge of 1 metre (3 ft. 3 3/8 in.) is particularly recommended in all those cases in which the new line which is to be built is not in direct connection with a narrow-gauge line of another gauge.

The German *Verein* has laid down the following conclusions in *Grz.*, paragraph 2, section 2 :

> The gauge of 1,000 millimetres or of 750 millimetres (3 ft. 3 3/8 in. or 2 ft. 5 1/2 in.) is recommended for narrow-gauge local lines. In the case of minor railways a gauge of 600 millimetres (1 ft. 11 5/8 in.) is still admissible. If a narrow-gauge system of larger extent, having another gauge, already exists, it is advisable also to select this gauge for an new lines added to it.

Such a narrow limitation of the same fundamental principle is hardly applicable in the case of the Congress, and it is probable that the general recommendation of a gauge of 1 metre (3 ft. 3 3/8 in.), without excluding other gauges which already exist, would better suit the objects which we are here considering; and it might be added that for lines which are to carry public traffic, the gauge of 600 millimetres (1 ft. 11 5/8 in.) is the smallest which can be recommended.

2° The gradients used on the different lines show much variety and it may here be mentioned that longer gradients of 25 to 30 per mil are reported by nine administrations, of up to 35 per mil by six, of up to 40 per mil by three and of up to 45 per mil by three administrations, while gradients of 58·8, 70 and 82·5 per mil

were each reported by one administration, and we may assume that the latter is the limit of what is ordinarily practicable in this way.

The development of the locomotive is not so much hampered by the presence of steep gradients, as it is by the other difficulties presented by the track. On the other hand, for a given horse-power, the gross ton-mileage is materially reduced by the reduction of the train weight including the load on the carrying wheels of the locomotive and of the tender, if any, proportionately to the adhesive weight of the locomotive.

This circumstance makes it evident that it is uneconomic to have excessive gradients on lines where the trains are hauled by steam locomotives, and this the more so, the smaller the ratio of the length of the steep gradients to the total length of the line.

Grz. prescribes in this respect in paragraph 21, section 1 :

> The gradient on adhesion railways shall as a rule not exceed 40 per mil (1 : 25),

and then adds provisions as to gradients on railways and as to easing off changes of gradients, which are outside the scope of this report.

The main statement quoted can be recommended in its general form, as it expresses that it is desirable not to have gradients steeper than 40 per mil; the qualification " as a rule " allows the engineer planning the line to select steeper gradients in special cases after careful consideration of all the circumstances, for and against, particularly of the higher initial outlay or cost of working.

3° The curves also show very great differences; we find everything from a very large minimum radius down to a radius of 21 metres (1·05 chains), as has already been mentioned under heading 1, " gauge ", of this summary.

These dimensions have a very great effect both on the service and on the design of the locomotives.

In the first place, they affect the admissible speed, and we will here only note that the maximum reported speeds of over 50 and up to 65 kilometres (over 31 and up to 40·4 miles) per hour are as a rule limited to lines having curves with a minimum radius of 180 metres (9 chains), while one administration reports a minimum radius of 70 metres (3 1/2 chains) and a maximum admissible speed of 64·4 kilometres (40·0 miles) per hour. We may assume that this speed is not usual on the sharp curves. On sharper curves, the maximum admissible speeds, for which the locomotives are designed, are reduced correspondingly, on the average to about 40 kilometres (25 miles) per hour with radii of 60 metres (3 chains) and to about 30 kilometres (18·6 miles) per hour with radii of 40 metres (2 chains).

Grz. prescribes in this respect in paragraph 22, section 1, clause c :

> The radius of curves on narrow-gauge lines shall as a rule not be less than :
>
> 50 metres (2 1/2 chains) on lines with a gauge of 1,000 millimetres (3 ft. 3 3/8 in.).
> 40 — (2 —) — — of 750 — (2 ft. 5 1/2 in.).
> 25 — (1 1/4 —) — — of 600 — (1 ft. 11 3/8 in.).

Smaller radii can be used on all these lines, if the rolling stock is specially designed for running round sharp curves.

Then prescriptions follow as to the transition curves and the length of straights between reverse curves, which are to be at least 10 metres (32 ft. 10 in.) in length between the two superelevation gradients.

If the three dimensions here considered: gauge, rigid wheelbase and radius of curve, are directly proportionate to each other, the axles of the vehicles in all cases form the same angles with the radii of the curve.

But as the length of the locomotives and consequently of the most advantageous wheelbase does not decrease proportionately to the gauge, the need arises not to establish a direct proportion between the gauge and the radii of the curves, but to have a greater ratio between these two dimensions in the case of narrower gauges than in that of wider gauges.

Taking this circumstance into consideration, and also the existing lines, it seems advisable to place the matter on a simpler basis and to recommend the general adoption of the radius of 40 metres (2 chains) as a minimum, and to make any further reduction in this dimension dependent on the use of rolling stock which is so equipped that the axles have the required adjustability on the curves.

The straights between reverse curves should be at least as long as the greatest distance between bogie centres of any vehicle, if no guard rails are laid at these curves.

4° The admissible axle-loads and the admissible loads per metre of track are, among all the conditions mentioned, the most important factors in the designing of powerful locomotives, particularly in the case of lines with steep gradients.

When we considered the different types of locomotives, we drew particular attention to the fact that some of the most powerful locomotives, giving the greatest tractive efforts, were designed for lines with very unfavourable curves, as it was possible to have great axle-loads.

Grz. prescribes, under construction and maintenance of rolling stock, in paragraph 41, section 2 :

The following maximum wheel-loads, measured in a state of rest, are recommended for the following gauges :

Gauge	1 metre.	750 millimetres,	600 millimetres;
	(3 ft. 3 3/8 in.),	(2 ft. 5 1/2 in.),	(1 ft. 11 5/8 in.);
Wheel-load . . .	4·5 tons,	4 tons,	3·5 tons.
	(4·4 English tons),	(3·9 English tons),	(3·4 English tons).

Now it is true that these maximum wheel-loads recommended, or the corresponding double axle-loads are not attained in many cases on the lines about which the administrations have sent us information, but in many cases they are materially exceeded. It does not seem advisable to include such " maximum wheel-loads recommended " in our conclusions, as they would tend to limit the development of the power of the locomotives even more than many of the other difficulties of narrow-gauge lines, such as the curves and gradients, and therefore we propose the

following wording : " An axle-load of 10 tons (9·8 English tons) is recommended for lines having a gauge of 1 metre (3 ft. 3 3/8 in.); it is advisable, particularly on lines with steep gradients and on lines with sharp curves, to have as heavy axle-loads as possible."

B. — *Conclusions as regards locomotives.*

1. We have dealt in detail with the question of the power of the locomotives when considering the different types of locomotives; in order to obtain the increased power required for operating a given traffic, the following measures are to be recommended :

a) Increasing the working pressure to 14 atmospheres;

b) Superheating the steam to 300° C. (572° Fahr.);

c) Compounding.

One or more of these measures can be applied simultaneously, according to the circumstances of each case.

2° The increase of the adhesive weight beyond the figure which is determined by the maximum wheelbases for given minimum radii, by the admissible axle-loads and the maximum admissible loads per metre of track, is in the case of lines with steep gradients just as important a question as the increase of power.

Grz. recommends in paragraphs 50 and 78 :

Locomotives and rolling stock which are to be used on lines where the under-mentioned curves frequently occur on the open line, should have rigid wheelbases not exceeding :

Curves having a radius, in metres (in chains) of

25, 40, 50, 75, 100, 125, 150, 180, 210, etc.
(1 1/4), (2), (2 1/2), (3 3/4), (5), (6 1/4), (7 1/2), (9), (10 1/2), etc..

Rigid wheelbase of locomotive, in metres

1·1, 1·5, 1·6, 2·0, 2·3, 2·6, 2·9, 3·2, 3·5, etc.
(3' 7 5/16"), (4' 11"), (5' 3"), (6' 6 3/4"), (7' 6 9/16"), (8' 6 3/8"), (9' 6 3/16"), (10' 6"), (11' 5 13/16"), etc.

Rigid wheelbase of carriages, in metres

1·4, 1·8, 2·0, 2·5, 2·9, 3·3, 3·6, 3·9, 4·3, etc.
(4' 7 1/8"), (5' 10 7/8"), (6' 6 3/4"), (8' 2 7/16"), (9' 6 3/16"), (10' 10"), 11' 9 3/4"), (12' 9 9/16"), (14' 1 5/16"), etc.

As regards the first, paragraph 51 states :

As regards locomotives with wheelbases exceeding the limits specified in paragraph 50, it is recommended to use bogies or radially-adjustable axles.

As regards carriages, the following is added to the other prescriptions :

The security of the traffic is not endangered, if the rigid wheelbases are a little larger,

and it recommended,

in the case of carriages with several axles, that there should be allowed a corresponding extra amount of lateral play.

As far as can be gathered from the information received in answer to our list of questions, the maximum wheelbases re-

commended by the German *Verein* for locomotives have been exceeded in a rather considerable number of cases; on the other hand (excluding some unexplained cases, very few in number) the wheelbases specified were not exceeded without having at least one or two of the coupled axles radially adjustable, or having one or two pairs of the coupled wheels made without flanges.

Accordingly when the wheelbase dimensions given above are exceeded, it is in the first place advisable to use adjustable coupled axles, and if this does not suffice, the use of special motor bogies is then to be recommended.

SECTION II.

First supplementary question.

Is it advisable to protect the wheels and the moving parts by a metal cover?

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1. — General considerations.

Twenty-eight administrations, who are enumerated in appendix II, part 2, have sent answers to this question; twelve of them limit themselves to the statement that they do not use such metal covers, although part of their lines also use public highways; sixteen of them make more or less detailed statements as to their views on this point; these are given in appendix II, part 3.

2. — The use of covers.

Comparing the answers as to the use of streets by the railways, and as to the use of covers, we obtain the following information :

Nine administrations use devices, either on some of their locomotives, or in some cases on all the locomotives of a given line, to protect the mechanism against dust; in the case of one locomotive type, the gear-wheel drive is enclosed in a dust-proof case so that it is completely protected against the action of any foreign bodies.

Seven of these nine administrations state that they also use streets; one gives no particulars, and one states that the whole of its line has its own road-bed.

Five administrations use no such protective coverings, although three of them have lines which use streets. Adding these to the twelve administrations previously mentioned, we find that there are altogether seventeen administrations not using any such protective coverings. Two of these administrations did use such covers formerly, but have removed them. This shows that the large majority of the administrations operating narrow-gauge lines, although many of them use streets, do not use such protective coverings.

3. — Results obtained in practice.

As regards results obtained in practice, the two administrations who formerly

used coverings but subsequently removed them, and one administration who still uses them, express the opinion that these coverings are unnecessary and make it more difficult to look after the locomotives.

Five administrations draw attention to the saving of the mechanism by the reduction of the wear; two of them however only expect real success if the whole is enclosed in a casing which is nearly dust-proof; this, apart from the closed gear-cases, can only be properly done in the case of outside frames, and one of the administrations expresses the opinion that a protective covering which is not really dust-tight is injurious rather than advantageous.

One administration thinks coverings are advisable in order to prevent the scaring of draft animals and to reduce damage in cases of collision or of grazing vehicles and persons, both for the latter and for the engine, while two administrations express the opposite opinion.

4. — Summary.

The chief question, whether the use of protective coverings seems necessary, and under what conditions it is to be recommended, or whether it appears to be superfluous, has been answered in many different ways, as was only to be expected from the treatment of the previous questions. The proportion of answers for and against is as follows :

Seven administrations consider protective coverings for the mechanism to be unnecessary, including firstly two administrations who formerly used such coverings and removed them, and one administration who is still using them; one of them states that the usual design is unsatisfactory, because it is not dust-proof; these three administrations have parts of their lines on streets; and secondly four administrations which do not use such coverings.

The same number, seven administrations, recommend protective coverings or consider their use desirable; six of them have used such coverings and one has not; two of these lines do not use the streets but have everywhere a road-bed of their own. One of them uses such coverings in order to economize in lubricating material and in the maintenance of the mechanism, as otherwise the dust which is raised would have a deleterious influence.

5. — Conclusions.

These contrary opinions are doubtless fully due, not only to the different importance attached to the advantages and disadvantages of such covers, but chiefly to the different conditions under which the traffic is operated. Not only has the quantity of dust to be considered in each individual case, but also its physical properties, particularly the hardness and the size and shape of its particles.

Those conditions make it impossible to give a general answer to the question; it will only be possible to give an answer in each individual case after the existing conditions have been considered.

The statements made enable the following general conclusion to be drawn : Protecting the wheels and the moving parts of the mechanism has as chief object the protection of the rubbing surfaces against foreign bodies, especially dust.

As secondary objects we may consider the fact that such locomotives scare animals, whether used for driving or for riding, less, and that in cases of collision or of grazing vehicles and persons, less damage is done. The coverings however make it more difficult to look after the engine, particularly at roadside stations with short stops; and care should be taken, when designing the arrangement, to provide for the easy accessibility of the mechanism.

If the locomotives are exposed to very dusty conditions, and if the dust consists of hard particles, the use of protective coverings is to be recommended, and the coverings should as far as possible be dust-proof and enclose the whole mechanism.

SECTION III.

Second supplementary question.

Is it advisable to have a footplate at each end of the locomotive? What regulations are there on the subject?

1. — General considerations.

Twenty-four administrations have sent answers to the list of questions on this subject, and nineteen have stated that their locomotives are only equipped with one footplate.

Thirteen of them have expressed no opinion as to the advisability of such an equipment, while six others consider it unnecessary, considering their traffic conditions; one administration considers it inadvisable. Thus there are five administrations left who have given an answer in the affirmative.

2. — Description of the designs.

A. — *With passage way round the locomotive.*

The Bavarian State Railway uses tank locomotive with two cabs, which are connected by a passage way round the locomotive; at each end there is a gangway by which the carriages can be reached.

The locomotive can only be driven from the one end, next the fire-box.

As it is possible to pass from the train to the locomotive while the train is in motion, the locomotive crew consists of one driver only. This naturally reduces the cost of traction, as the cost of a fireman is saved, and hence is worth special attention in connexion with narrow-gauge working.

B. — *Raised cab.*

The Arad-Csnad Railway has special tractors which it uses on its narrow-gauge lines.

These are distinguished by having a raised cab in the middle of the vehicle, from which an unobstructed view can be obtained in every direction.

The question of how a cab should be

arranged, to enable the driver to obtain as unobstructed a view as possible over the track and the adjoining parts, is no doubt solved in this case in the best possible way. This solution is however only available in cases where there is no ordinary locomotive or other boiler of large capacity, but only a steam generator without or with only a very small water-space. The expensive fuel required for such a boiler will however in many cases prove an obstacle te the extension of this system.

C. — *Two driver's cabs.*

The Belgian National Suburban Railway Company and the Aisne Department Railway use on street lines locomotives which have a cab at each end; both the regulator and the cut-off can be operated from each of the cabs. This arrangement enables the driver to have an unobstructed view over his track and over any streets joining the one on which the track is laid. The object aimed at is attained without undue multiplication of parts. On one type gangway, connections are provided, making it possible to pass from the train to the locomotive; in the other type, this is not the case. The turning of the locomotives, and the turntables necessary for this purpose, are saved in those cases in which the street lines pass through streets in which there is so much traffic that a cab which is at the back or in the middle can no longer be considered sufficiently safe. The cost of constructing and of maintaining the turntables is saved in this way, and the cost of working is reduced because the time required for turning at the end of the journey is saved. These administrations state this arrangement is to be recommended under these particular conditions.

D. — *Driver's cab on the carriages.*

The Great Western Railway (England) has introduced a peculiar design, which strictly speaking does not fall within the scope of this question, but which nevertheless has a similar object in view. It is intended for use on a standard-gauge line having its own road-bed, but can be also applied as it is to a narrow-gauge line, and hence is noticed here. A complete train consisting of two carriages and a tank locomotive is coupled up permanently so as to be able to run in either direction; the locomotive is placed between the two carriages. Each of these carriages has a cab at one end, the two cabs being at the head and at the tail of the train. The regulator can be operated from either cab by means of a mechanical rod and lever transmission. The driver is in that cab which is at the head of the train, the fireman is on the locomotive. It is not possible to pass from the carriage to the locomotive while the train is running; the employees on the train communicate by means of whistle and bell signals.

This arrangement makes it possible for the driver to have a clear view over the track and makes it unnecessary to shift the locomotive to the head of the train; it seems very suitable in the case of a shuttle service on a short section of line, where the direction of running is frequently reversed. Firstly, the time is saved, which would otherwise be required for shunting operations, and secondly the station line which would have to be kept clear for

these shunting operations, can be utilized for other purposes.

3. — Conclusions.

1° In the case of railways which use streets where there are many crossings and much traffic, it seems advisable to arrange matters in such a way that the driver not only has a good view from his locomotive over his track, but that he also can obtain as soon as possible a good view of any streets joining from either side. Leaving any turning of the locomotive at the terminus out of consideration, this object can be attained either by having a cab at each end of the locomotive, together with the necessary equipment for operating the regulator and the cut-off and for giving signals, or, if the locomotive is short, by having a raised cab from which it is possible to obtain an unobstructed view in any direction,

2° If the locomotive crew is to consist of one man only, it must be possible to pass from the carriages to the locomotive while the train is running; in the case of tank locomotives, this can be attained by having two footplates with gangway connexions. Only one of the footplates need be equipped with gear for driving the locomotive;

3° In the case of a shuttle service with a train of two carriages, the locomotive can be placed in the middle, if at least the regulator can be operated from the cabs at each end of the train.

CONCLUSIONS.

The consideration of the information given about existing locomotives and the examination of the relation between their chief properties and the character of the line, and the strength of the road and the roadbed lead to the following conclusions.

SECTION I.

Locomotives suited to the character of the line and of the traffic on narrow-gauge railways.

A. — *The design of new narrow-gauge lines which are to be operated with steam locomotives, are to be used for public traffic, and have to deal with a considerable amount of passenger or goods traffic.*

1° In all the cases in which the selection of the gauge of a new line is not decided in advance by its immediate junction with another line or by some other administrative connection with an existing narrow-gauge system, a gauge of 1 metre (3 ft. $3^3/_8$ in.) is considered the best. A smaller gauge than 600 millimetres (1 ft. 11 $^5/_8$ in.), and the selection of a new gauge which does not yet exist, are not to be recommended;

2° In the case of adhesion lines, whose locomotives work without any artificial increase of friction, it appears as a rule advisable not to have steeper gradients than 40 per mil;

3° It is recommended as a rule not to have curves with a radius of less than 40 metres (2 chains), if the vehicles are not specially designed for sharper curves. It is desirable to have the straights between the superelevation gradients of reverse curves, which are not equipped with guard rails, not shorter than the greatest existing distance between the bogies of a vehicle;

4° If a busy traffic has to be dealt with, it appears advisable to build the road and road-bed of a line having a gauge of 1 metre (3 ft. 3 3/8 in.), of such a strength that it can stand an axle-load of 10 tons (9·84 English tons); it is recommended, particularly in the case of lines with steep gradients and sharp curves, to provide for greater axle-loads.

B. — *As regards the design of new locomotives.*

1° The following may be recommended in order to increase the power of locomotives :

a) The use of a working pressure of up to 14 atmospheres;

b) Superheating the steam to 300° C. (572° Fahr.);

c) Compounding.

2° On lines on which the following curves frequently occur on the open line, no greater rigid wheelbases should be used than those given in the following table :

Radius of curve, in metres (in chains) :
25, 40, 50, 75, 100, 125, 150, 180 (1 1/4, 2, 2 1/2, 3 3/4, 5, 6 1/4, 7 1/2, 9).

Rigid wheelbase, in metres :
1·4, 1·8, 2·0, 2 5, 2·9, 3·3, 3·6, 3·9 (4' 7 1/8", 5' 10 7/8", 6' 6 3/4", 8' 2 7/16", 9' 6 3/16", 10' 10", 11' 9 3/4", 12' 9 9/16").

If the adhesive weight necessary can not be obtained inside the limits set by these wheelbases and the admissible maximum axle-loads, then, according to the excess required, the following arrangements can be recommended :

a) Lateral play;

b) Not having flanges on some of the pairs of coupled wheels; if these measures do not suffice, then;

c) Having some of the coupled axles radially adjustable; and finally

d) The use of one or two motor bogies movable relatively to the main frame, with mechanical transmission from one main steam engine or each with a separate steam engine.

SECTION II

Is it advisable to protect the wheels and the moving parts by a metal cover?

1° Locomotives which are liable to suffer from an unusual amount of dust, can have their moving parts protected by a covering, which is to enclose, as far as

possible, all the moving parts, and is to be as dust-proof as possible. Doors are to be provided in this covering so as to make the moving parts as accessible as possible;

2° Such coverings may also help to some extent to prevent the scaring of draft animals and to reduce damage in cases of collision with other vehicles, animals and persons.

SECTION III.

Is it advisable to have a footplate at each end of the locomotive?

1° In the case of lines which use streets in thickly-populated towns with much traffic, it is advisable to arrange matters so that the driver can in good time obtain an unobstructed view of any side streets crossing the line.

If it is not possible always to turn the locomotives so as to be head on, it is advisable to have a cab at each end of the locomotive; it must be possible to operate the regulator and the cut-off from each cab, and to give the necessary signals.

Tractors with a raised cab, from which an unobstructed view a can be obtained in every direction, satisfy this requirement without any need for turning them;

2° If the locomotive crew is to consist of one man only, it must be possible to pass from the train to the locomotive while running; this can be effected in the case of tank locomotives by having two footplates with gangway connexions. Only one of the footplates need be equipped for driving;

3° In the case of a shuttle service with a train of two carriages running on its own road-bed the locomotive can be placed in the middle, if it is possible to operate at least the regulator and the brakes from the carriage-cabs at the ends of the train.

APPENDIX I.

1. — Detailed list of questions relating to question XIX.

QUESTION 1. — *Particulars of the track.*

a) Gauge?

b) Smallest radius of curves: on the open line at switches?

c) Shortest straight between reserve curves:
Length of straight?
Radii?

d) Steepest gradient considered per mil, length?

QUESTION 2. — *Construction of locomotives for adhesion lines operated by steam; if possible, supply sketch of typical example, on a scale of 1 : 50, showing chief dimensions.*

a) Year of purchase?

b) Name of works, where locomotive was built?

c) Number of locomotives, of the different types?

d) Arrangement of axles:
Carrying axles, number?
— wheels, diameter?
— — wheel-load?
— — play, radial?
— — play, lateral?
— — used together in a truck?
Driving axles and coupled axled, number?
Diameter of wheels (D)?
Axle-load, in working order?
Lateral play?
Coupled up to form several driving sets?
Total length of locomotives over buffers?
Total wheelbase?
Rigid wheelbase?
Total weight in working order?
Adhesive weight?

e) *Arrangement of boiler.* — A sketch is desirable in the case of unusual constructions:
Heating surface of fire-box?
— — smoke-tubes?
— — superheater?
— — total?
Grate area?
System of smoke consumption?
Working pressure (p)?
Temperature of steam?

f) *Engine:*
Twin working?
Compound working-system?
Number of cylinders high pressure?
— — low pressure?
Diameter (d_h) high pressure?
— (d_n) low pressure?
Stroke?
System of valve gear?
Type of slide valve?
Theoretical tractive effort in the case of twin working $\frac{p \cdot d^2 \cdot l}{D}$?
of compound working, 2 cylinders $0{\cdot}75\frac{p \cdot d_h^2 \cdot l}{D}$?
of compound working, 4 cylinders $1{\cdot}5\frac{p \cdot d_h^2 \cdot l}{D}$?
Highest admissible speed?

g) *Brakes :*

Compressed-air system?
Vacuum-system?
Automatic action?
Number of axles braked?

h) *Steam heating?*

i) *Capacity :*

Of water tanks?
Of coal bunkers?

k) *separate tender?*

l) *Power of the locomotives :*

Fuel : source?
Fuel : designation of quality?
— lignite?
— brown coal?
— pit coal?
— anthracite?
— liquid fuel?
Its calorimetric value?
It evaporates on locomotives of the type this quantity of water?
With the fuel used there is a continuous output of horse power?
Normal weight of train, locomotive excluded :
On a gradient of per mil?
And at an absolute speed of miles per hour?

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2. — List of the Administrations who sent answers to the list of questions relating to subject XIX, littera A.

A. — Railways with a gauge of 610 millimetres (2 feet).

GREAT BRITAIN AND IRELAND,

COLONIES IN SOUTH AFRICA.

1. — Central South African Railways.
2. — Natal Government Railways.

B. — Railways with a gauge of 750 millimetres (2 ft. 5 1/2 in.).

GERMANY.

1. — Saxon State Railway.
2. — Wurtemberg State Railway.

EGYPT.

3. — Fayoum Light Railways Company.

RUSSIA.

4. — First Secondary Railway Company of Russia.

C. — Railways with a gauge of 760 or 762 millim. (2 ft. 5 15/16 in. or 2 ft. 6 in.).

AUSTRIA AND HUNGARY.

a) AUSTRIA.

1. — Austrian State Railway.
2. — Bukovina Light Railway.
3. — Austrian Southern Railway.

b) HUNGARY.

4. — Arad-Csanad Railway.
5. — Kaschau-Oderberg Railway.

GREAT BRITAIN AND IRELAND.

EMPIRE OF INDIA.

6. — Bengal-Nagpur Railway.
7. — Eastern Bengal State Railway.
8. — North Western State Railway.
9. — Bombay, Baroda and Central India Railway.

D. — Railways with a gauge of 785 millimetres (2 ft. $6\,^{29}/_{32}$ in).

GERMANY.

1. — Prussian-Hessian State Railway, Kattowitz Directorate.

E. — Railways with a gauge of 890 or 891 mill (2 ft. $11\,^{3}/_{64}$ in, or 2 ft. $11\,^{5}/_{64}$ in.).

SWEDEN.

1. — Swedish State Railway.
2. — Stockholm Rimbo Railway.

F. — Railways with a gauge of 914 millimetres (3 feet).

UNITED STATES OF AMERICA.

1. — Baltimore and Ohio Railroad.
2. — Chicago, Burlington and Quincy Railroad.
3. — Pennsylvania Lines West of Pittsburgh.
4. — Southern Pacific Company.

G. — Railways with a gauge of 950 millimetres (3 ft. $1\,^{3}/_{8}$ in.).

ITALY.

1 — Italian State Railway.

H. — Railways with a gauge of 1 metre (3 ft. $3\,^{3}/_{8}$ in.).

GERMANY.

1. — Alsace-Lorraine Railway.
2. — Bavarian State Railway.
3. — Prussian-Hessian State Railway, Erfurt Directorate.
4. — Saxon State Railway.
5. — Wurtemberg State Railway.

ARGENTINE REPUBLIC.

6 — Argentine Northern Railway.

SPAIN.

7. — Spanish Northern Railway.

FRANCE.

8. — Orleans Railway.
9. — Paris-Lyons-Mediterranean Railway.
10. — St. Quentin-Guise and Aisne Department Railway.

ITALY.

11. — Société anonyme d'entreprise générale de travaux.

LUXEMBURG.

12. — Prinz-Heinrich Railway.

PORTUGAL.

13. — Portuguese National Railway Company.

RUSSIA.

14. — Riazan-Ural Railway.

SWITZERLAND.

15. — Swiss Federal Railway.
16. — Rhetian Railway.

I. — Railways with a gauge of 1,067 millimetres (3 ft. 6 in.).

BELGIUM.

1. — Belgian National Suburban Railway Company.

NORWAY.

2. — Norwegian State Railway.

RUSSIA.

3. — Moscow-Vindau-Rybinsk Railway.

SWEDEN.

4. — Swedish State Railway.

3. — Summary of the Ans

Chief dimensions and particu

Index number.	NAME OF RAILWAY.	Number and type of locomotives. (1) — Arrangement of axles.	Radius of sharpest curve on the open line at switches, in metres (2)	Steepest gradient, in millimetres per metre.	Weight, in tons.	Tota weig in tons
	A. — For a gauge of 610 millimetres.					
1	Central South African Railways	T. L. -B-	100	16·6	6·1	6·
2 (4)	Natal Government Railways	6 T. L. 2 C 1	61	30·0	17·42	26·
	B. — For a gauge of 750 millimetres.					
1 *a* (4)	Saxon State Railway	45 T. L. B + B	50/43	40·0	27·4	27·
1 *b* (4)		9 T. L. -D-	50/43	40·0	28·7	28·
2 (4)	Wurtemberg State Railway	8 T. L. B + B	100/50	25·0	28·7	28·
3	Fayoum Light Railways Company	6 T. L. 1-C-1	40/30	30·0	20·36	28·
4 *a* (4)	First Secondary Railway Company of Russia	91 L. s. T. -D-	106·7/64	15·0	21·36	21· (36·
4 *b*		13 T. L. -D-	106·7/64	15·0	21·0	21·
	C. — For a gauge of 760 and 762 millimetres.					
1 *a* (4)	Austrian State Railway	41 T. L. -C 1	60	32·0	19·2	24·
1 *b* (4)		3 T. L. -C 1	60	32·0	22·9	27·
1 *c* (4)		3 T. L. -C 2	60	32·0	17·9	26·
2 (4)	Bukovina Light Railway	2 T. L. -D-	100/65	17·0	16·8	16·
3 *a*	Austrian Southern Railway. — Kühnsdorf-Eisenkappel Local Railway	2 T. L. -C 1	60	27·54	13·0	17·
3 *b*	Mori-Arco-Riva Company	4 T. L. -C 1	50	32·4	18·0	22·
3 *c* (4)		3 T. L. -C-	80/65	25·0	19·5	19·
3 *d*	Styrian Country Railway. — Kapfenberg-Au-Seewiesen line	1 T. L. -C 1	80/65	25·0	19·2	24·
3 *e* (4)	Preding Wieselsdorf-Stainz & Pöltschach-Gonobitz lines	4 T. L. -B-	60	16 0	12·0	12·

(1) T. L. = Tank locomotive. — L. s. T. = Locomotive with separate tender.
(2) The radius of curves at switches is only given when it is smaller there than on the open line.

he questions.

he design of the locomotives.

in tons.	Wheelbase.		Working pressure, in atmospheres.	Maximum speed admissible, in kilometres per hour.	Power given, in horse-power.	Date of acquisition.	*Remarks.*
	Coupled wheels, in millimetres.	Total, tender excluded, in millimetres.					
			A. — For a gauge of 610 millimetres.				
05	1,067	1,067	9·8	?	35	...	
815	1,752	5,409	11·6	24.1	215	1907	
			B. — For a gauge of 750 millimetres.				
·9	2 × 1,400	6,200	12	30	205	1892-1908	Compound Mayer system, four cylinders.
·5	3,900	3,900	14	30	250	1901	Compound, first and fourth coupled axles of the Klien-Lindner system.
·6	2 × 1,350	4,440	12	30	230	1890-1908	Compound Mallet-Rimrott system, four cylinders.
·12	1,900	5,180	12	35	116	1907	
·54	2,700	2,700	12	32	220 (5) (197)	1898-1902	(5) Fired with wood.
·5	2,4 0	2,400	12	26	145 ,5	1895	The horse-power is calculated as in the other cases on the basis of coal-firing.
			C. — For a gauge of 760 and 762 millimetres.				
·6	2,100	4,000	12	35	190	1897-1908	Smoke consumer.
·7	2,100	4,000	13	35	270	1904	Compound working.
·0	2,100	4,800	13	40	280	1896	Compound working.
·2	2,130	2,130	13	25	150	1908	Compound working.
·4	1,700	3,300	12	25	120	1902	
·0	2,100	4,000	12	25	160	1890-1892	
·5	2,100	2,100	12	35	150	1903	
·4	2,100	4,000	12	40	190	1895	Very similar to type 1*a*, apart from minor alterations.
·0	1,600	1,600	12	25	95	1892	

The weight of the locomotive, tender included, is given in brackets.
For the corresponding description see appendix 1, section 4.

Chief dimensions and particu

Index number.	NAME OF RAILWAY.	Number and type of locomotives. (1) Arrangement of axles.	Radius of sharpest curve on the open line at switches, in metres (2)	Steepest gradient, in millimetres per metre.	Weight, in tons.	Tota weigl in tons (
	C. — For a gauge of 760 and 762 millimetres. (*Continued.*)					
4 (4)	Arad-Csanad Railway.	2 tracteurs A 1 A	60/52	10	8·2	11·5
5 (4)	Kaschau-Oderberg Railway	3 T. L. -D-	65/60	22·5	24·0	24·0
6 *a* (4)	Bengal-Nagpur Railway (762 millimetres)	16 T. L. 1 D 2	117/86	12·5	27·12	42·9
6 *b* (4)		30 L. s. T. 1 D 1	117/86	12·5	28·44	39·7 (58·9
6 *c* (4)		20 L. s. T. 2 C 1	117/86	12·5	20·73	33·7 (52·3
7	Eastern Bengal State Railway (762 millimetres)	8. T. L. 1 B-	152·4	19	9·26	13·4
8 *a*	North Western State Railway (762 millimetres)	10 T. L. -B 1	73·0	12	17·2	21·8
8 *b* (4)(5)		18 T. L. 1 C 1	73·0	12	25·70	34·1
8 *e*		3 L. s. T. -C 1	73·0	12	12 93	17·2 (28·3
8 *f*		3 L. s. T. 1 B 1	73·0	12	8·46	13·4 (20·6
8 *g*		10 T. L. 1 B 1	73·0	12	6·60	11·7
8 *h*		6 L. s. T -C 1	73·0	12	18·4	23·9 (39 9
9 (4)	Bombay, Baroda & Central India Railway (762 millimetr s) . . .	3 L. s. T. -C 1	152·4/91·4	6·6	13·01	16·4 (27·8
	D. — For a gauge of 785 millimetres.					
1 *a* (4)	Prussian-Hessian State Railway, Kattowitz Directorate	39 T. L. -C-	40/35	40	16·45	16·4
1 *b* (4)		4 T. L. C + B	40/35	40	27·15	27·1
1 *c* (4)		2 T. L. -D-	40/35	40	26·79	26·7
1 *d* (4)		10 T. L. -D-	40/35	40	27·34	27·3

(1) T. L. = Tank Locomotive; L. s. T. = Locomotive with separate tender.
(2) The radius of curves at switches is only given when it is smaller there than on the open line.

he design of the locomotives. (Continued.)

in tons.	Wheelbase.		Working pressure, in atmospheres.	Maximum speed admissible, in kilometres per hour.	Power given, in horse-power.	Date of acquisition.	*Remarks.*
	Coupled wheels, in millimetres.	Total, tender excluded, in millimetres.					
			C. — For a gauge of 760 and 762 millimetres. (*Continued.*)				
1	(5)	4,000	18·25	35	75	1904	(5) Compound working, with four cylinders. Tractor with two flexible axles separately driven.
0	4,000	4,000	12	25	185	1908	First and fourth coupled axle of the Klien-Lindner design.
22	2,922	8,384	11·3	24·1	290	1905	Large stores of water and of fuel.
11	2,922	6,961	12	24·1	410	1907-1909	
01	2,438	7,201	12	24·1	345	1906-1909	
64	1,295	2,590	10·5	24·1	80	1893-1901	
6	1,676	3,276	9·8	24·1	135	...	
6	1,828	5,333	12·7	24·1	275	1904	(6) Of three similar types, the heaviest is given.
31	1,828	3,428	10·5	24·1	125	1899	
37	1,219	3,988	10·5	24·1	70	1904	
4	1,219	3,963	10·5	24·1	75	1900	
15	1,904	3,352	10·5	24·1	195	1899	
37	2,134	4,039	11·2	32·2	200	1903	
			D. — For a gauge of 785 millimetres.				
56	1,800	1,800	12	25	105	1876-1901	
49	1,770 1,000	4,650	12	25	220	1898-1901	Movable motor bogie, on the Hagans system.
71	4,050	4,050	12·5	25	215	1902	First and fourth coupled axle of the Klien-Lindner design.
01	3,900	3,900	13	25	210	1904-1907	First and fourth coupled axle of the Klien-Lindner design.

e weight of the locomotive, tender included, is given in brackets.
r the corresponding description see appendix I, section 4.

Chief dimensions and particu

Index number.		NAME OF RAILWAY.	Number and type of locomotives. (1) Arrangement of axles.	Radius of sharpest curve on the open line. at switches, in metres. (2)	Steepest gradient, in millimetres per metre.	Weight, in tons.	Total weight in tons.
		E. — For a gauge of 890 and 891 millimetres.					
1	*a* (4)	Swedish State Railway Lines (890 millimetres). Stockholm-Rimbo	3 L. s. T. 1 C-	200/125	(3)	20·0	24·3 (41·3)
1	*b* (4)	Dala-Ockelbo	4 L. s. T. 1 D-	148/119	27·6	26·4	29·4 (41·4)
1	*c* (4)	Hvetlanda-Säfsjö	1 T. L. 1 D-	200/100	20·0	24·2	28·0
1	*d* (4)	Kinnekulle-Lidköping	66 T. L. 1 C-	190/150	16·0	21·0	25·53
1	*e* (4)	Uddevalla-Lelången	8 T. L. 2 B 1	180/140	16·6	14·4	31·42
1	*f* (4)	Nora-Oestergötland	4 T. L 1 C 1	300/150	16·0	20·95	33·50
1	*g* (4)	Västergötland-Göteborg	9 L. s. T. 1 C-	200/150	16·8	21·15	25·19 (45·22
2	*a* (4)	Stockholm-Rimbo Railway (891 millimetres)	3 L. s. T. 1 C-	205/125	20·0	20·0	24·28
2	*b*		3 L. s. T. -D-	200/125	20·0	26·9	26·9
2	*c*		3 T. L. 1-C-1	200/125	20·0	21·0	34·0
		F. — For a gauge of 914 millimetres.					
1	*a*	Baltimore & Ohio Railroad	5 L. s. T. 2 C-	70	28·9	23·79	30·6
1	*b*		2 L. s. T. 1 D-	70	28·9	26·2	30·5
1	*c*		1 L. s. T. 2 B-	70	28·9	14·5	22·7
1	*d*		1 L. s. T. 1 C-	70	28·9	21·03	22·5
2	*a* (4)	Chicago Burlington & Quincy Railway	4 L. s. T. 1 C-	47	82·5	26·76	32·2
2	*b* (4)		4 L. s. T. 1 D-	47	82·5	44·62	49·6
3 (4)		Pennsylvania Lines West of Pittsburg	6 L. s. T. 1 C-	53·5	25·6	19·05	22·2

(1) T. L. = Tank locomotive. — L. s. T. = Locomotive with separate tender.
(2) The radius of curves at switches is only given when it is smaller there than on the open line.

he design of the locomotives. (Continued.)

in tons.	Wheelbase.		Working pressure, in atmospheres.	Maximum speed admissible, in kilometres per hour.	Power given, in horse-power.	Date of acquisition.	*Remarks.*
	Coupled wheels, in millimetres.	Total, tender excluded, in millimetres.					
			E. — For a gauge of 890 and 891 millimetres				
7	3,400	5,400	12.5	60	270	1904-1906	Compound working.
55	4,300	6,200	12	35	260	1906	
1	3,400	5,200	11	(?)	190	1907	
05	3,230	4,880	12	50	200	1902-1908	
20	2,200	6,650	12	65	225	1903	
0	3,000	6,275	11	50	280	1906	Steam superheated to 300° C.
05	3,100	5,020	11	50	250	1901-1909	Steam superheated to 300° C.
72	3,400	5,400	12·5	57	275	1904-1906	Compound working.
8	4,300	4,300	12	32	250	1906	
0	3,000	7,000	11	57	260	...	Steam superheated.
			F. — For a gauge of 914 millimetres.				
93	2,743	5,486	9·8	64·4	235	1890	
55	3,460	5,479	9·8	64·4	260	1882	
25	2,210	5,614	9·8	64·4	180	1882	
01	3,073	4,902	9·8	64·4	180	1882	
	3,206	5,435	10·6	?	275	1882	Of eight very similar types, the most powerful is given
	3,023	5,182	12·7	?	500	1900	
	2,895	4,724	10·6	48·2	170	1889-1903	

weight of the locomotive, tender included, is geven in brackets.

the corresponding description see appendix I, section 4.

Chief dimensions and particu

Index number.		NAME OF RAILWAY.	Number and type of locomotives. (1) Arrangement of axles.	Radius of sharpest curve on the open line at switches, in metres (2)	Steepest gradient, in millimètres per metre.	Weight, in tons.	Tota weigh in tons (3
		F. — For a gauge of 914 millimetres. (*Continued.*)					
4	*a*	Southern Pacific Company	6 L. s. T. 2 B-	?	?	14·9	24·9
4	*b*		2 L. s. T. 1 C-	?	?	18·8	22·6
4	*c*		4 L. s. T. 2 C-	?	?	25·4	33·5
4	*d*		1 L. s. T. 1 D-	?	?	23·4	25·9
		G. — For a gauge of 950 millimetres.					
1 (4)		Italian State Railway	12 T. L. -D-	100	25·0	47·9	47·9
		H. — For a gauge of 1,000 millimetres.					
1	*a*	Alsace-Lorraine Railway	8 T. L. -C-	50	33·0	17·93	17·9
1	*b* (4)		10 T. L. -D-	50	33·0	28·65	28·6
2	*a* (4)	Bavarian State Railway	3 T. L. 1 C-	21	58·82	22·8	26·
2	*b*		1 T. L. -D-	60/45	25·0	23·4	23·
3	*a* (4)	Prussian-Hessian State Railway, Erfurt Directorate	2 T. L. -C-	40	33·3	27·35	27·
3	*b* (4)		1 T. L. C_1	40	33·3	17·46	21·
3	*c* (4)		1 T. L. -D-	40	33·3	29·67	29·
4 (4)		Saxon State Railway	3 T. L. B + B	30/25	25·0	41·8	41·
5 (4)		Wurtemberg State Railway	3 T. L. -D-	80/70	40·0	29·8	29·
6	*a* (4)	Argentine Northern Railway	9 L. s. T. 2 C-	450/180	12·0	32·98	40· (73·
6	*b*		4 L. s. T. 2 C-	450/180	12·0	32·4	40· (78·

(1) T. L. = Tank locomotive; L. s. T. = Locomotive with separate tender.
(2) The radius of curves at switches is only given when it is smaller there than on the open line.

e design of the locomotives. (Continued.)

in tons.	Wheelbase.		Working pressure, in atmospheres.	Maximum speed admissible, in kilometres per hour.	Power given, in horse-power.	Date of acquisition.	*Remarks.*
	Coupled wheels, in millimetres.	Total, tender excluded, in millimetres.					
			F. — For a gauge of 914 millimetres. (*Continued.*)				
	2,489	6,706	9.8	?	= 230	1881-1889	
	3,658	5,588	9.8	?	= 200	1881-1889	
	3,810	6,655	9.8	?	= 270	1881-1889	
75	3,454	5,436	9.8	?	= 240	1881-1889	
			G. — For a gauge of 950 millimetres.				
5	3,750	3,750	14	?	430	1909	
			H. — For a gauge of 1,000 millimetres.				
07	1,800	1,800	12	30	105	1890-1899	
5	3,400	3,400	12	30	185	1903-1908	The last coupled axle is in a Bissel truck and is driven by a loose axle.
3	1,800	3,400	12	30	195	1906	Steam superheated.
9	2,600	2,600	12	30	180	1909	
45	2,250	2,250	12	30	190	1908	
82	2,100	3,800	12	30	145	1899	
6	3,300	3,300	12	30	185	1902	The fourth axle is a hollow axle.
6	2 × 1,100	7,600	14	30	395	1902	Compound, four cylinders, Fairlie design.
5	4,000	4,000	12	30	260	1891-1899	The first and the fourth axles are radially adjustable, on the Klose system.
5	3,660	6,640	12	?	460	1905	For wood firing. The power is calculated for coal.
0	3,300	6,125	12	?	320	1904	

weight of the locomotive, tender included, is given in brackets.
the corresponding description see appendix I, section 4.

Chief dimensions and parti

Index number.		NAME OF RAILWAY.	Number and type of locomotives. (1) Arrangement of axles.	Radius of sharpest curve on the open line at switches in metres (2).	Steepest gradient, in millimetres per metre.	Weight, in tons.	T wi to
		H. — For a gauge of 1,000 millimetres. (*Continued.*)					
7	*a*	Spanish Northern Railway	6 T. L. 2 B-	89·56	29·86	16·0	
7	*b*		2 T. L. -C-	89·56	29·86	26·0	
8	*a*	Orleans Railway — Blois-St. Aignan	T. L. -C-	40	30·0	15·6	
8	*b*	Orleans Railway — Blanc-Argent line	T. L. -C-	150/52	15·0	19·61	
8	c_1	Orleans Railway — Coreze line	T. L. 1 B-	100	30·0	19·2	
8	c_2 (4)		T. L. B + B	100	30·0	40·0	
9		Paris Lyons-Mediterranean Railway	5 T. L. 1 C-	100/90	20·0	26·43	
10	*a*	St. Quentin-Guise Railway	4 T. L. 1 C-	100/50	35·0	18·0	
10	*b* (4)		3 T. L. -B 2	40	44·0	?	
10	*c*		1 T. L. -C-	40	44·0	18·0	
11		Romagnes steam tramway company Société anonyme d'entreprise générale de travaux	3 T. L. -B-	40/30	No steep incline.	16·0	
12		Prinz-Heinrich Railway	2 T. L. -C-	100/96	35·0	28·98	
13	*a*	Portuguese National Railway Company	10 T. L. 1 C-	150/100	18·0	25·0	
13	*b* (4)		6 T. L. -C-	150/100	18·0	25·0	
14	*a* (4)	Riazan-Ural Railway	4 L. s. T. 1 C-	426/?	8·0	15·75	
14	*b*		54 L. s. T. -D-	426/?	8·0	21·96	
15	*a*	Swiss Federal Railway	10 T. L. -C-	150/90	18·0	25·0	
15	*b*		2 T. L. 1 C-	150/90	18·0	26·4	
16 (4)		Rhetian Railway	11 L. s. T. 1 D-	100/90	45·0	41·6	

(1) T. L. = Tank Locomotive. — L. s. T. = Locomotive with separate tender.
(2) The radius of curves at switches is only given when it is smaller there than on the open line.

design of the locomotives. (Continued.)

Wheelbase.		Working pressure, in atmospheres.	Maximum speed admissible, in kilometres per hour.	Power given, in horse-power.	Date of acquisition.	*Remarks.*
Coupled wheels, in millimètres.	Total, tender excluded, in millimetres.					
H. — For a gauge of 1,000 millimetres. (*Continued.*)						
1,931	5,029	8·0	40	110	1888	
2,600	2,600	9·0	40	150	1888	
1,800	1,800	12·0	30	120	1898	
2,100	2,100	10·0	50	120	1900-1901	
1,700	3,900	10·0	40	155	1903	
2×1,700	5,270	14·0	40	370	1905-1906	Two motor bogies, Mallet design, compound, four cylinders.
2,350	4,190	12·0	50	260	1907	
2,290	4,100	12·0	?	185	1906	
1,400	7,700	...	?	70	1907	Automotor with vertical boiler.
1,800	1,800	12·0	?	130	1907	
1,500	1,500	12·4	35	115	1908-1909	
2,450	2,450	...	?	?	1903	
2,850	4,700	11·0	45	325	1886-1908	
2,850	2,850	10·0	45	220	1888	
3,506	5,335	8·0	37.5	110	1894	Fired with naphtha; the power can be estimated at 140 horse-power when this fuel is used.
3,501	3,501	11·0	32	215	1893-1894	Fired with naphtha; the power can be estimated at 270 horse-power when this fuel is used.
2,500	2,500	11·0	45	195	1887-1901	
2,000	4,900	12·0	45	250	1905	
4,050	6,100	12·0	45	520	1906-1909	Superheated steam, smoke consumer.

weight of the locomotive, tender included, is given in brackets.
the corresponding description see appendix I, section 4.

Chief dimensions and part

Index Number.		NAME OF RAILWAY.	Number and type of locomotives. (1) Arrangement of axles.	Radius of sharpest curve on the open line. at switches, in metres (2)	Steepest gradient, in millimetres par metre.	Weight in tons.	T w to
		I. — For a gauge of 1,067 millimetres.					
1 (4)		Belgian National Suburban Railway Company	561 T. L. - C -	25	70	29·0	2
2	*a*		9 L. s. T, 2 B-	188/100	23·8	13·8	2 (3
2	*b* (4)	Norwegian State Railway.	6 T. L. 1 C 1	188/100	23·8	17·8	2
2	*c*		17 L. s. T. 1 C-	188/100	23·8	19·4	2 (3
3	*a* (4)		9 L. s. T. 2 B-	322/178	6·6	12·0	1
3	*b*	Moscow-Vindau-Rybinsk Railway	2 T. L. 1 B-	322/178	6·6	12·0	1
	c		9 L. s. T. - C -	322/178	6·6	16·0	1
4		Swedish State Railway	2 L. s. T. 1 C-	300/150	16·6	22·745	2 (4

(1) T. L. = Tank locomotive — L. s. T. = Locomotive with separate tender.
(2) The radius of curves at switches is only given when it is smaller there than on the open line.

design of the locomotives. (Continued.)

Wheelbasse.		Working pressure, in atmospheres.	Maximum speed admissible, in kilometres per hour.	Power given, in horse-power.	Date of acquisition.	*Remarks.*
Coupled wheels, in millimetres.	Total tender excluded, in millimetres.					
I. — For a gauge of 1,067 millimètres.						
2,000	2,000	12	40	200	1884 and following year.	561 locomotives, of two similar types, have been built for gauges of 1,000 and 1,067 millimetres; one of them is given here.
1,905	5,308	12	60	190	1893-1900	Compound working.
3,330	7,100	10	55	155	1895 1908	
3,400	5,200	13	55	225	1901-1909	Compound working.
2,360	5,460	10	50	155 (5)	1871-1878	
1,900	2,960	10	41	110 (5)	1871	(5) For wood-firing; the power is calculated for coal.
2,744	2,744	8	31	110 (5)	1878	
2,920	4,800	10	50	235	1907	

veight of the locomotive, tender included, is given in brackets.
ne corresponding description see appendix I, section 4.

4. — Particulars of noteworthy types.

A. — Railways with a gauge of 610 millimetres (2 feet).

GREAT BRITAIN, COLONIES IN SOUTH AFRICA.

2. — *Natal Government Railways, Africa.*

Eastcourt-Weenen-Branch connects farming centres with the main lines.

Radius of sharpest curves on the open line : 61 metres (3·05 chains).

Radius of sharpest curves at switches : 64 metres (3·2 chains).

Shortest straight between reverse curves : 12 metres (13·1 yards).

Steepest gradient considered : 30 per mil with a corresponding reduction on curves

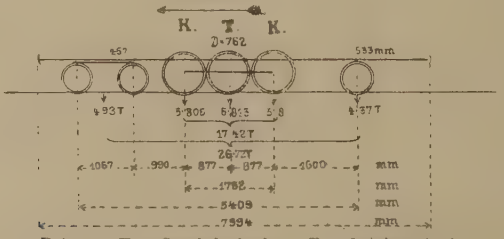
Year of purchase of locomotive : 1907.

Tank locomotive supplied by Hawthorn Leslie Co., Limited, Newcastle-on-Tyne (fig. 1).

Number : 6.

Adjustability of axles : lateral play of bogie, 76 millimetres (3 inches) ; of bissel truck, 102 millimetres (4 inches).

Arrangement of axles.



Reference : K. = Coupled wheels. — T. = Driving wheels.

Heating surface :

Fire-box. . .	3·7	sq. metres	(39·8 sq. feet).
Smoke-tubes.	58·9	—	(634·8 —).
Total. . .	62·6	sq. metres	(673·8 sq. feet).

Grate area : 1·02 sq. metres (11 sq. feet).

Working pressure : $p = 11{\cdot}6$ atmospheres.

Working : Twin-working.

Dimensions of cylinders :

$d \times l = 292 \times 381$ millim. ($11\ ^1/_2'' \times 1'\ 3''$).

System of valve gear : Walschaerts, with flat side valves.

Theoretical tractive effort according to the formula $\frac{p \cdot d^2 \cdot l}{D} = 9{,}400$ kilog. (20,723 lb.).

Highest admissible speed : 24 1 kilometres (15 miles) per hour.

System of brakes steam and hand brake : Acting on three pairs of wheels.

Steam heating : none.

Capacity for coal, 1·2 cubic metres (42·3 cubic feet) ; water, 3·6 cubic metres (792 English gallons).

When using bituminous coal of round Natal, train weighing 70 tons gross (68·9 English tons), is hauled up a gradient of 30 per mil at a speed of 14·5 kilometres (9 miles) per hour.

B. — Railways with a gauge of millimetres (2 ft. $5\ ^1/_2$ in.).

GERMANY.

1. — *Saxon State Railway.*

Radius of sharpest curves on the open line : 50 metres ($2\ ^1/_2$ chains).

Radius of sharpest curves at switches : 43 metres (2 15 chains).

Shortest straight between reverse curves : 10 metres (10·9 yards).

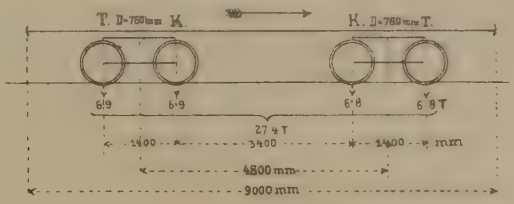
Steepest gradient considered : 40 per mil.

Year of purchase of locomotive : 1892 to 1908.

a) Tank locomotive supplied by the " Sächsische Maschinenfabrik " formerly R. Hartmann, Chemnitz in Saxony (fig. 2).

Number : 45

Arrangement of axles.



Adjustability of axles : Two combined in each bogie.

Heating surface :

Fire-box . . .	4·10 sq. metres	(44·13 sq. feet).
Smoke-tubes.	45·74	—	(492·35 —).
Total . . .	49·84 sq. metres	(536·48 sq. feet).

Grate area : 0·97 sq. metre (10·4 sq. feet).

Working pressure : p = 12 to 14 atmospheres.

Compound working : Meyer System.

Dimensions of cylinders (4) :

$d \times l$ { 2 × 240 × 380 mill. (9 7/16" × 1' 3").
2 × 370 × 380 — (1' 2 9/16" × 1' 3").

System of valve gear : Heusinger with flat side and Trick port valve.

Theoretical tractive effort according to the formula $1{\cdot}5 \frac{p \cdot d_h^2 \cdot l}{D}$ = 5,148 kilog. (11,349 lb.).

Highest admissible speed : 30 kilometres (18·6 miles) per hour.

Automatic brake acting on three pairs of wheels.

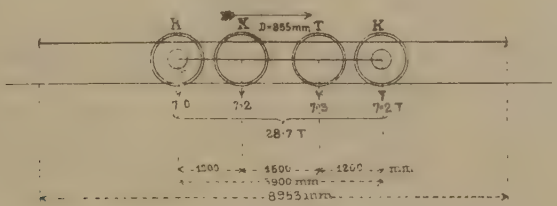
Capacity for coal, 1 cubic metre (35·3 cubic feet) ; water, 2·4 cubic metres (528 English gallons).

Year of purchase of locomotive : 1901.

b) Tank locomotive supplied by the " Sächsische Maschinenfabrik " formerly R. Hartmann Chemnitz in Saxony (fig. 3).

Number : 9.

Arrangement of axles.



Adjustability of axles : first and fourth coupled axle on the Klien-Lindner System.

Heating surface :

Fire-box. . .	4·22 sq metres	(45·42 sq. feet).
Smoke-tubes.	45·74	—	(492·35 —).
Total. . .	49·96 sq. metres	(537·77 sq. feet).

Grate area : 0·97 sq. metre (10·44 sq. feet).

Working pressure : p = 14 atmospheres.

Compound working.

Dimensions of cylinders :

$d \times l$ { 340 × 430 mill. (1' 1 3/8" × 1' 5").
530 × 430 — (1' 8 7/8" × 1' 4 15/16").

System of valve gear : Heusinger with flat slide valves and Trick port valve.

Theoretical tractive effort according to the formula $0{\cdot}75\frac{p \cdot d_h^2 \cdot l}{D} = 6{,}105$ kilog. (13,459 lb.).

Highest admissible speed : 30 kilometres (18·6 miles per hour.

Brakes acting on two pairs of wheels.

Capacity for coal, 1·2 cubic metres (42·3 cubic feet); water, 2 4 cubic metres (528 English gallons).

2. — *Wurtemberg State Railway.*

Radius of sharpest curves on the open line : 100 metres (5 chains).

Radius of sharpest curves at switches : 50 metres (2 1/2 chains).

Shortest straight between reverse curves : 38 metres long (41·5 yards) between curves having radii of 500 and 300 metres (25 and 15 chains).

Strepest gradient considered, 25 per mil on a length of 1,800 metres (1,969 yards).

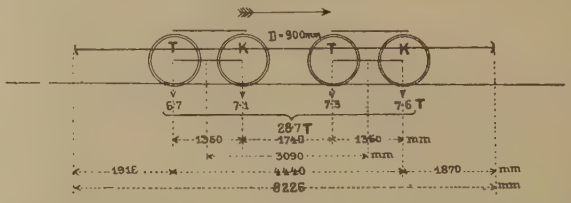
Years of purchase of locomotive 1899-1908.

Tank locomotive supplied by the "Maschinen Fabrik Esslingen" (fig. 4).

Number : 8.

Adjustability of axles : two combined in each bogie, on the Mallet-Rimrott system.

Arrangement of axles.



Heating surface :

Fire-box. . .	4·5	sq. metres	(48·4 sq. feet).
Smoke-tubes.	51·9	—	(558·6 —
Total . . .	56·4	sq. metres	(607·0 sq. feet).

Grate area : 0 98 sq. metre (10·54 sq. feet).

Working pressure : $p = 12$ atmospheres.

Compound-working.

Dimensions of cylinders (4) :

$d \times l$ { $2 \times 275 \times 450$ mill. ($10\,{}^{13}/_{16}' \times 1'\,5\,{}^{11}/_{16}''$).
{ $2 \times 420 \times 450$ — ($1'\,4\,{}^{9}/_{16}'' \times 1'\,5\,{}^{11}/_{16}''$).

System of valve year : Heusinger von Waldegg with Trick port valves.

Theoretical tractive effort according to the formula $1{\cdot}5\frac{p \cdot d_h^2 \cdot l}{D} = 6{,}800$ kil. (14,991 lb.).

Highest admissible speed : 30 kilometres (18·6 miles) per hour.

System of brakes : Westinghouse acting on two pairs of wheels.

Steam heating.

Capacity for coal, 1·2 cubic metres (42 3 cubic feet); water, 2·5 cubic metres (550 English gallons).

When using Saar and Ruhr coal mixed which evaporates 7·5 to 8 times its weight of water, 240 horse-power are developed and a train weighing 90 tons gross (88·6 English tons), is hauled up a gradient of 25 per mil at a speed of 20 kilometres (12·4 miles) per hour.

RUSSIA.

4. — *First secondary Railway Company of Russia.*

Radius of sharpest curves on the open line : 106·7 metres (5·33 chains).

Radius of sharpest curves at switches : 64 metres (3·2 chains).

Shortest straight between reverse curves : 22·4 metres (24·5 yards).

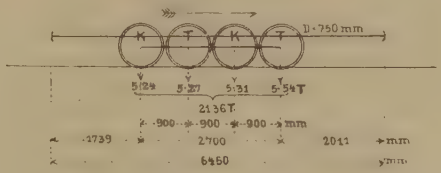
Steepest gradient considered : 15 per mil over a length of 853 metres (933 yards).

Year of purchase of locomotives : 1898, 1902 and 1908.

Locomotive with separate tender supplied by Kolomna Works.

Number : 91.

Arrangement of axles.



Adjustability of axles : 14 millimetres ($^9/_{16}$ inch) of lateral play.

Heating surface :

Fire-box. . .	6.0 sq. metres	(64·5 sq. feet).
Smoke-tubes.	49·6 —	(533·9 —).
Total. . .	55·6 sq. metres	(598·4 sq. feet).

Grate area : 1·15 sq. metres (12·37 sq. feet).

Working pressure : $p = 12$ atmospheres.

Twin-working.

Dimensions of cylinders :

$d \times l = 355 \times 300$ millim. ($1' 2'' \times 11\ ^{13}/_{16}''$).

System of valve gear Heusinger.

Theoretical tractive effort according to the formula $\frac{p \cdot d^2 \cdot l}{D} = 6{,}049$ kilog. (13,358 lb.).

Highest admissible speed : 32 kilometres (19·9 miles) per hour.

Steam heating : Screw breake.

Capacity for fuel = 5 cubic metres (177 cubic feet); water, 5·4 cubic metres (1,188 English gallons).

When using birch wood and pine wood 197 horse-power are developed and a train weighing 202 tons gross (198·8 English tons), is hauled up a gradient of 8 per mil at a speed of 21 kilometres (13·0 miles) per hour.

C. — Railways with a gauge of 760 or 762 millimetres (2 ft. 5 $^{29}/_{32}$ in. or 2 ft. 6 in.).

AUSTRIA AND HUNGARY.

Gauge : 760 millimetres (2 ft. 5 $^{29}/_{32}$ in.).

a) Austria.

1. — *Austrian State Railway.*

Radius of sharpest curves on the open line : 60 metres (3 chains).

Radius of sharpest curves at switches : 65 metres (3 $^1/_4$ chains).

Shortest straight between reverse curves : 7 metres (7·6 yards).

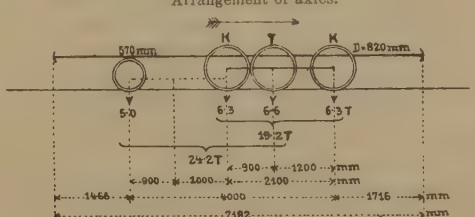
Steepest gradient considered : 32 per mil.

Year of purchase of locomotive : 1897 — 1908.

a) Tank locomotive supplied by Krauss & Co., Linz; Lokomotivfabrik, Wiener Neustadt; Maschinenfabrik der Staatseisenbahn-Gesellschaft; I Böhm-Mahr. Maschinen Fabrik (fig. 5).

Number : 41.

Arrangement of axles.



Adjustability of axles ; Bissel truck with lateral play of 35 millimetres (1 3/8 inches) of the last coupled axle, which has a play of 25 millimetres (1 inch) towards either side, effects the lateral displacement.

Heating surface :

Fire-box. . .	4·42 sq. metres	(47·57 sq. feet).
Smoke-tubes.	46·28 —	(498·17 —).
Total. . .	50·70 sq. metres	(545·74 sq. feet).

Grate area : 1 sq. metre (10·76 sq. feet).

Working pressure : $p = 12$ atmospheres.

Smoke consumer : Marek system.

Twin-working.

Dimensions of cylinders :

$d \times l = 290 \times 400$ millim. ($11\ 7/16'' \times 1'3\ 3/4''$).

System of valve gear : Heusinger von Waldegg with flat valves.

Theoretical tractive effort according to the formula $\frac{p \cdot d^2 \cdot l}{D} = 5{,}046$ kilog. (11,125 lb.).

Highest admissible speed : 35 kilometres (21·7 chains).

System of brakes vacuum automatic : Acting on two pairs of wheels.

Capacity for coal, 1·7 cubic metre (60 cubic feet); water, 3·2 cubic metres (704 English gallons).

When using Hinterholz coal which evaporates 5·2 times its weight of water 225 horse-power are developed and a train weighing 95 tons gross (93·5 English tons) is hauled up a gradient of 10 per mil at a speed of 35 kilometres (21·7 miles) per hour.

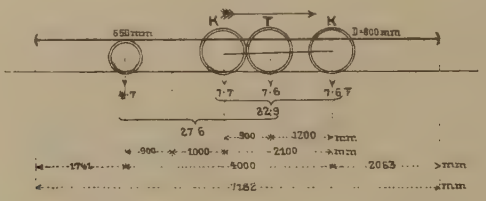
—

Year of purchase of locomotive : 1904.

b) Tank locomotive supplied by the Lokomotivfabrik Krauss & Co., Linz (fig. 6).

Number : 3.

Arrangement of axles.



Adjustability of axles : Bissel truck with lateral play of 35 millimetres (1 3/8 inches) towards either side, effects the lateral displacement of the last coupled axle, which has a play of 25 millimetres (1 inch).

Heating surface :

Fire-box. . .	4·6 sq. metres	(49 5 sq. feet).
Smoke-tubes.	57·8 —	(622·1 —).
Total. . .	62·4 sq. metres	(671·6 sq. feet).

Grate area : 1·03 sq. metre (11·08 sq. feet).

Working pressure : $p = 13$ atmospheres.

Compound working.

Dimensions of cylinders :

$d \times l = \frac{320}{500}$ mill. $\left(\frac{1'0\ 19/32''}{1'7\ 14/16''}\right) \times 400$ mill. ($1'3\ 3/4''$).

System of valve year : Heusinger-Waldegg with flat valves.

Theoretical tractive effort according to the for, mula $0.75 \frac{p \cdot d^2 \cdot l}{D} = 4{,}855$ kilog. (10,703 lb.).

Highest admissible speed : 35 kilometres (21.7 miles) per hour.

System of brakes vacuum automatic : Acting on two pairs of wheels.

Steam heating.

Capacity for coal, 1·7 cubic metres (60 cubic feet); water, 3·1 cubic metres (682 English gallons).

When using upper Silesian coal which evaporates 6·7 times its weight of water 273 horse-

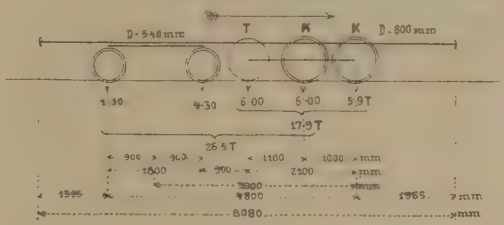
power are developed and a train weighing 115 tons gross (113·2 English tons), is hauled up a gradient of 10 per mil at a speed of 35 kilometres (21·7 miles) per hour.

Year of purchase of locomotive : 1896.

c) Tank locomotive supplied by Krauss & Co., Linz (fig. 7).

Number : 3.

Arrangement of axles



Adjustability of axles : carrying axles in bogie, driving without flanges.

Heating surface :

Fire-box . .	4·30 sq. metres	(46 28 sq. feet).
Smoke-tubes	61·4 —	(660·92 —).
Total . .	65·70 sq. metres	(707.20 sq. feet).

Grate area : 1·03 square metres (11·08 sq. feet).

Working pressure : $p = 13$ atmospheres.

Compound-working.

Dimensions of cylinders :

$$d \times l = \frac{310}{450} \times 400 \text{ mill.} \left(\frac{1' \, 3\,{}^{3}/_{16}''}{1' \, 5\,{}^{11}/_{16}''} \times 1' \, 3\,{}^{3}/_{4}'' \right).$$

System of valve year : Heusinger von Waldegg, with flat valves.

Theoretical tractive effort according of the formula $0{\cdot}75 \frac{p' \cdot d^2 \cdot l}{D} = 4{,}685$ kilog. (10,328 lb.).

Highest admissible speed : 40 kilometres (24·8 miles) per hour.

System of brakes vacuum automatic : acting on two pairs of wheels.

Steam heating.

Capacity for coal, 1 cubic metre (35·3 cubic feet); water, 3 cubic metres (660 Engl. gallons).

When using Newcastle coal which evaporates 6·95 times its weight of water 284 horse-power are developed and a train weighing 100 tons gross (98·4 English tons), is hauled up a gradient of 10 per mil at a speed of 40 kilometres (24·8 miles) per hour.

—

2. — *Bukovina Local Railway.*

Name of line Czudin-Koszczuja.

Radius of sharpest curves on the spen line : 100 metres (5 chains).

Radius of sharpest curves at switches : 65 metres (3 ¼ chains).

Shortest straight between reverse curves : 100 metres (109 yards) between curves having a radius of 200 metres (10 chains).

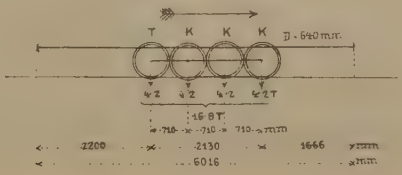
Steepest gradient considered : 17 per mil; length, 830 metres (908 yards).

Year of purchase of locomotive : 1908.

Tank locomotive supplied by Krauss & Co., Linz (fig. 8).

Number : 2.

Arrangement of axles.



Adjustability of axles : this two middle axles have a lateral play of 20 millimetres ($^{13}/_{16}$ inch).

Heating surface :

Fire-box . .	3·59 sq. metres	(38 64 sq. feet).
Smoke-tubes	26·95	—	(290·09 | — |).
Total . .	30·54 sq. metres	(328·73 sq feet).

Grate area : 0·706 sq. metre (7·599 sq. feet).

Working pressure : $p = 13$ atmospheres.

Compound-working.

Dimensions of cylindres :

$$d \times l = \frac{270}{410} \times 340 \text{ mill.} \left(\frac{10\ ^5/_8''}{1'\ 4\ ^5/_{32}''} \times 1'\ 1\ ^3/_8'' \right).$$

System of valve year : Heusinger von Waldegg, with flat valves.

Theoretical tractive effort according to the formula $0{\cdot}75 \frac{p \cdot d_h^2 \cdot l}{D} = 3{,}776$ kilog. (8,325 lb.).

Highest admissible speed : 25 kilometres (15·5 miles) per hour.

Screw brakes, acting on two pairs of wheels.

Steam heating.

Capacity for coal, 1·6 cubic metres (56·5 cubic feet) ; water, 2 cubic metres (440 English gallons).

When using upper Silesian coal, which evaporates 6·3 times its weight of water, a train weighing 100 tons gross (98·4 English tons), is hauled up a gradient of 17 per mil at a speed of 10 kilometres (6·2 miles) per hour.

—

3. — *Austrian Southern Railway, as managing administration.*

c) Styrian Country Railway. Kapfenberg Au-Seewiesen line.

Radius of sharpest curves on the open line : 80 metres (4 chains).

Radius of sharpest curves at switches : 65 metres (3 $^1/_4$ chains).

Shortest straight between reverse curves : 23·85 metres (26·08 yards) between curves having radii of 80 and 90 metres (4 and 4 $^1/_2$ chains).

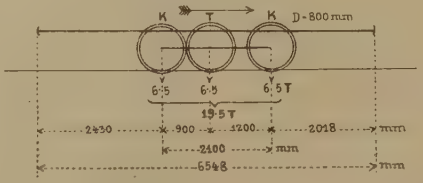
Steepest gradient considered : 25 per mil.

Year of purchase of locomotive : 1893.

Tank locomotive supplied by the Lokomotivfabrik Krauss & Co., Linz (fig. 9).

Number : 3.

Arrangement of axles.



Heating surface :

Fire-box. . .	3 sq. metres	(32·29 sq. feet).
Smoke-tubes.	37	—	(398·27 | — |).
Total. . .	40 sq. metres	(430·56 sq. feet).

Grate area : 0·77 square metre (8·28 sq. feet).

Working pressure : $p = 12$ atmospheres.

Twin-working.

Dimensions of cylinders :

$d \times l = 290 \times 400$ millim. ($11\ ^7/_{16}'' \times 1'\ 3\ ^3/_4''$).

System of valve year : Heusinger von Waldegg, with flat valves.

Theoretical tractive effort according to the formula $\frac{p \cdot d^2 \cdot l}{D} = 5{,}046$ kilog. (11,126 lb.).

Highest admissible speed : 35 kilometres (21·7 miles) per hour.

System of brakes vacuum : acting on three pairs of wheels.

Steam heating : none.

Capacity for coal, 1 cubic metre (35·3 cubic feet) ; water, 2·26 cubic metres (497·4 English gallons).

When using Ostrau coal 150 horse-power are developed and a train weighing 70 tons gross

(68·9 English tons), is hauled up a gradient of 25 per mil at a speed of 15·2 kilometres (9·4 miles) per hour.

—

e) Styrian country railway, Preding-Wieselsdorf and Pöltschach-Gonobitz lines.

Radius of sharpest curves on the open line : 60 metres (3 chains).

Radius of sharpest curves at switches : 65 metres (3 1/4 chains).

Shortest straight between reverse curves : 21 metres (22·9 yards).

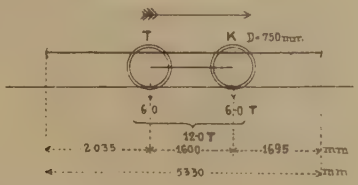
Steepest gradient considered : 16 per mil.

Year of purchase of locomotive : 1892.

Tank locomotive supplied by the Lokomotivfabrik Krauss & Co., Linz (fig. 10).

Number : 2.

Arrangement of axles.



Heating surface :

Fire-box. . .	2·36 sq. metres	(25·40 sq. feet).
Smoke-tubes.	21·35 —	(229·81 —
Total. . . .	23·71 sq. metres	(255·21 sq. feet).

Grate area : 0·51 sq metre (5·49 sq. feet).

Working pressure : $p = 12$ atmospheres.

Twin-working.

Dimensions of cylinders :

$d \times l = 225 \times 350$ millim. (8 7/8″ × 1′ 1 3/4″).

System of valve year : Stephenson, with flat valves.

Theoretical tractive effort according to the formula $\frac{p \cdot d^2 \cdot l}{D} = 2{,}835$ kilog. (6,250 lb.).

Highest admissible speed : 25 kilometres (15·5 miles) per hour.

System of brakes vacuum : acting on two pairs of wheels.

Steam heating.

Capacity for coal : 0·7 cubic metre (24·7 cubic feet); water, 1·15 cubic metre (253·1 English gallons).

When using lignite coal 70 horse-power are developed and a train weighing 80 tons gross (78 7 English tons), is hauled up a gradient of 16 per mil at a speed of 12·3 kilometres (7·6 miles) per hour.

—

b) Hungary.

4. — *Arad-Csanad Railways.*

First Lower Hungarian Agricultural line.

Radius of sharpest curves on the open line : 60 metres (3 chains).

Radius of sharpest curves at switches : 52 metres (2·6 chains).

Shortest straight between reverse curves : 10 metres (10·9 yards).

Steepest gradient considered : 10 per mil.

Tractors.

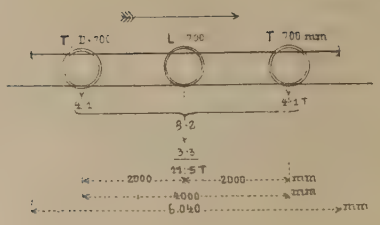
Year of purchase of locomotive : 1904.

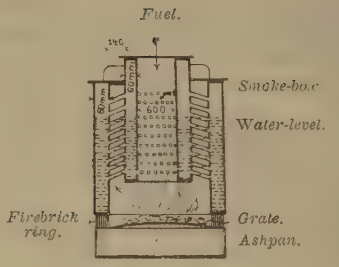
Tank locomotive supplied by the locomotive works of the Hungarian state railway.

Number : 2.

Adjustability of axles : free flexible axle.

Arrangement of axles.





Heating surface :

Water-tubes.	2 × 6·4 sq. met.	(2 × 68·9 sq. ft.).
Superheater.	2 × 2·2 —	(2 × 23·7 —).
Total. . .	17·2 sq. metres	(185·2 sq feet).

Grate area : 2 × 1·1 sq. met. (11·8 sq. feet).

Working pressure : $p = 18$ to 25 atmospheres.

Compound-working in four cylinders.

Dimensions of cylinders :

$$d \times l = \frac{2 \times 116}{2 \times 170} \times 140 \text{ millimetres}$$

$$\left(\frac{2 \times 4\ ^{9}/_{16} \text{ inches}}{2 \times 6\ ^{11}/_{16} \text{ inches}} \times 5\ ^{1}/_{2} \text{ inches}\right).$$

Theoretical tractive effort according to the formula $1{\cdot}5 \frac{p \cdot d_h^2 \cdot l}{D} = 1{,}010$ kilog. (2,227 lb.).

Highest admissible speed : 35 kilometres (21·7 miles) per hour.

Hand brake : acting on two pairs of wheels.

Steam heating.

Capacity for coal, 2 cubic metres (70·6 cubic feet); water, 2 cubic metres (440 English gallons).

When using charcoal or coke, which evaporates 6·5 times its weight of water 75 horse-power are developed and a train weighing 80 tons gross (78·7 English tons), is hauled up a gradient of 10 per mil at a speed of 15 kilometres (9·3 miles) per hour.

—

5. — *Kaschau-Oderberg Railway.*

Rózsahegy-Korytinca.

Radius of sharpest curves on the open line : 65 metres (3 ¼ chains).

Radius of sharpest curves at switches : 60 metres (3 chains).

Shortest straight between reverse curves : 25 metres (27 yards).

Steepest gradient considered : 22·5 per mil.

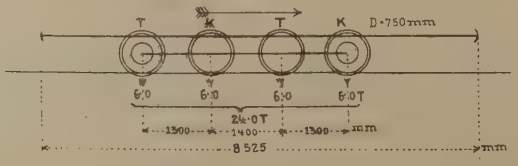
Year of purchase of locomotive : 1908.

Tank locomotive supplied by the locomotive works of the Hungarian State Railway, Budapest.

Number : 3.

Adjustability of axles on the Klien-Lindner system.

Arrangement of axles.



Heating surface :

Fire-box. . .	4·38 sq. metres	(47·14 sq. feet).
Smoke-tubes.	44·23 —	(476·10 —).
Total. . .	48·61 sq. metres	(523·24 sq. feet).

Grate area : 0·9 sq. metre (9·68 sq. feet).

Working pressure : $p = 12$ atmospheres.

Twin working.

Dimensions of cylinders :

$d \times l = 340 \times 350$ mill. (1′ 1 3/8″ × 1′ 1 1/16″).

System of valve gear : Stephenson with flat valves.

Theoretical tractive effort according to the formula $\frac{p \cdot d^2 \cdot l}{D} = 6{,}470$ kilog. (14,264 lb.).

Highest admissible speed : 25 kilometres (15·5 miles) per hour.

System of brakes screw brake: acting on two pairs of wheels.

Steam heating.

Capacity for coal, 1·32 cubic metres (46·62 cubic feet); water, 2·30 cubic metres (506·2 English gallons).

GREAT BRITAIN, COLONIES IN INDIA.

(Gauge : 762 millimetres [2 ft. 6 in.]).

6 — *Bengal Nagpur Railway.*

Radius of sharpest curves on the open line : 125 metres (6 1/4 chains) as a rule but there are two curves with 117 metres (5·85 chains).

Radius of sharpest curves at switches : 86 metres (4·3 chains); but all new ones have radii of 110 metres (5 1/2 chains).

Shortest straight between reverse curves : 14 metres (15·3 yards), between curves with radii of 436 and 125 metres (21·8 and 6 1/4 chains).

Steepest gradient considered 12·5 per mil.

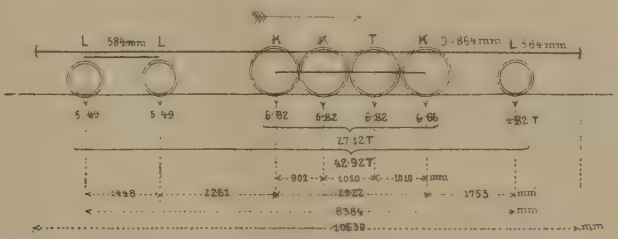
Year of purchase of locomotive : 1905.

a) Tank locomotive for mixed traffic supplied by North British Locomotive Company.

Number : 16.

Adjustability of axles : radial play 2 1/4°, lateral play 1/8 inch, two axles together in a bogie.

Arrangement of axles.



Heating surface :

Fire-box. . .	6·21 sq. metres	(66·84 sq. feet).
Smoke-tubes.	77·74 —	(836·81 —).
Total. . .	83·95 sq. metres	(903·65 sq. feet).

Grate area : 1·5 sq. metre (16·14 sq. feet).

Working pressure : $p = 11.3$ atmospheres.

Twin working in 2.

Dimensions of cylinders :

$d \times l = 368 \times 457$ mill. (1′ 2 1/2″ × 1′ 6″).

System of valve gear : Walschaerts with balanced D valves.

Theoretical tractive effort according to the formula $\frac{p \cdot d^2 \cdot l}{D} = 8{,}520$ kilog. (18,783 lb.).

Highest admissible speed : 24 kilometres (14.9 miles) per hour.

System of brakes steam for locomotive and automatic vacuum for train : acting on three pairs of wheels.

Capacity for coal, 3 cubic metres (105·9 cubic feet); water, 6·3 cubic metres (1,386·6 English gallons).

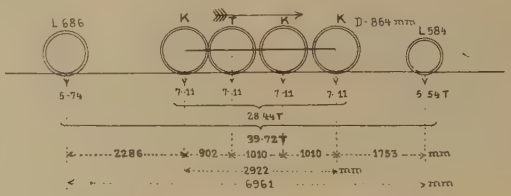
Pench Valley coal is used.

Year of purchase of locomotive : 1907-1909.

b) Locomotive with separate tender for goods trains supplied by North British Locomotive Co.

Number : 30.

Arrangement of axles.



Adjustability of axles : two Bissel axles, radial play 2 $^1/_4$°.

Heating surface :

Fire-box . .	7·33 sq. metres	(78·90 sq. feet).
Smoke-tubes	107·0 —	(1,151·78 —).
Total . .	114·33 sq. metres	(1,230·68 sq. feet).

Grate area : 1·91 sq. metres (20·55 sq. feet).

Working pressure : $p = 12$ atmospheres.

Twin working with two cylinders.

Dimensions of cylinders :

$d \times l = 368 \times 457$ mill. ($1' 2\ ^1/_2'' \times 1' 6''$).

System of valve gear : Walschaerts, with balanced D valves.

Theoretical tractive effort according to the formula $\frac{p \cdot d^2 \cdot l}{D} = 9{,}090$ kilog. (20,040 lb.).

Highest admissible speed : 24 kilometres (14·9 miles) per hour.

System of brakes steam brake for locomotive and tender : acting on three pairs of wheels of the locomotive and three pairs of wheels of the tender, automatic vacuum brake for train.

Steam heating : none.

Capacity for coal, 3 cubic metres (105·9 cubic feet) ; water, 7·7 cubic metres (1,694·7 English gallons).

Pench Valley coal is used.

—

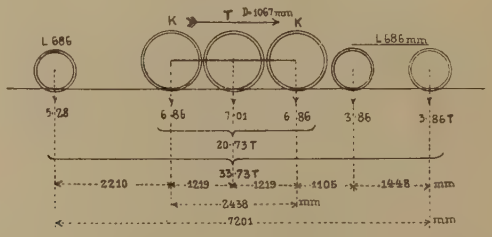
Year of purchase of locomotive : 1906-1909.

c) Locomotive with separate tender for passenger trains supplied by North British Locomotive Co.

Number : 20.

Adjustability of axles : radial play 1 $^1/_2$°, lateral play $^1/_8$ inch, two axles together in a bogie.

Arrangement of axles.



Heating surface :

Fire-box . .	6·12 sq. metres	(65·87 sq. feet).
Smoke-tubes	90·39 —	(972·98 —).
Total. . .	96·51 sq. metres	(1,038 85 sq. feet).

Grate area : 1·62 sq. metres (17·43 sq. feet).

Working pressure : $p = 11{\cdot}3$ atmospheres.

Twin working.

Dimensions of cylinders :

$d \times l = 368 \times 457$ mill. ($1' 2\,^1/_2'' \times 1' 6''$).

System of valve year : Walschaerts, with balanced D valves.

Theoretical tractive effort according to the formula $\frac{p \cdot d^2 \cdot l}{D} = 6{,}890$ kilog. (15,190 lb.).

Highest admissible speed : 24 kilometres (14·9 miles) per hour.

System of brakes steam brake for locomotive and tender : acting on three pairs of wheels of the locomotive and three pairs of wheels of the tender, automatic vacuum brake for the train.

Steam heating : none.

Capacity for coal, 3 cubic metres (105·9 cubic feet); water, 7·7 cubic metres (1,694·7 English gallons).

Pench Valley coal is used.

8. — *North Western State Railway.*

Kohat-Thal Railway & Nowshera-Dargai Railway.

Radius of sharpest curves on the spen line : 73 and 84 metres (3·65 and 4·2 chains).

Radius of sharpest curves at switches : 111 metres (5·55 chains).

Shortest straight between reverse curves : 20 metres (21·9 yards).

Steepest gradient considered : 10 and 12 per mil.

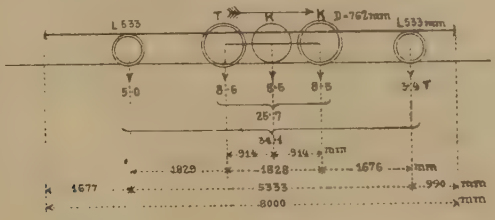
Year of purchase of locomotive : 1904.

Tank locomotive supplied by North British Locomotive Co., Limited.

Number : 2.

Adjustability of axles : carrying wheels radially adjustable ; the middle has wheels without flanges.

Arrangement of axles.



Heating surface :

Fire-box. . .	5·9 sq. metres	(63·59 sq. feet).
Smoke-tubes.	63·7 —	(685·60 —).
Total. . .	69·6 sq. metres	(749·19 sq. feet).

Grate area : 1·32 sq. metres (14·21 sq. feet).

Working pressure : $p = 12{\cdot}7$ atmospheres.

Twin working.

Dimensions of cylinders :

$d \times l = 356 \times 406$ millim. ($1' 2'' \times 1' 4''$).

Theoretical tractive effort according to the formula $\frac{p \cdot d^2 \cdot l}{D} = 8{,}550$ kilog. (18,850 lb.).

Highest admissible speed : 24·1 kilometres (15·0 miles) per hour.

System of brakes vacuum automatic : acting on three pairs of wheels.

Steam heating : none.

Capacity for coal, 1·9 cubic metres (67·1 cubic feet); water, 3·05 cubic metres (671·3 English gallons).

Pit coal is used, and a train weighing 80 tons (78·7 English tons) gross is hauled.

—

9. — *Bombay, Baroda and Central India Railway.*

Radius of sharpest curves on the open line : 152·4 metres (7·68 chains).

Radius of sharpest curves at switches : 91·4 metres (4·57 chains).

*

Shortest straight between reverse curves : 30·1 metres (32·9 yards) between curves having radii of 873 and 524 metres (43·65 and 26·2 chains).

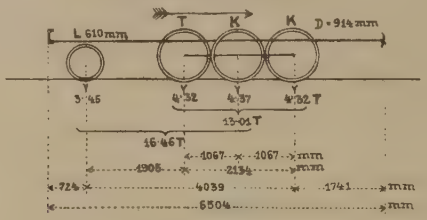
Steepest gradient considered : 6·66 per mil.

Year of purchase of locomotive : 1903.

Locomotive with separate tender supplied by Kitson & Co., Leeds (England).

Number 3 in use and several on order.

Arrangement of axles.



Adjustability of axles : carrying axle in pony truck, lateral play 76 millimetres (3 inches).

Heating surface :

Fire-box. . .	6·1 sq. metres	(65·66 sq. feet).
Smoke-tubes.	46·0 —	(495·15 —).
Total. . .	52·1 sq. metres	(560·81 sq. feet).

Grate area : 1·1 sq. metres (11·84 sq. feet).

Working pressure : $p = 11{\cdot}2$ atmospheres.

Twin-working.

Dimensions of cylinders :

$d \times l = 279 \times 381$ millim. ($11'' \times 1'\ 3''$).

System of valve gear : Walschaerts modified by Kitson, with flat valves.

Theoretical tractive effort according to the formula $\frac{p \cdot d^2 \cdot l}{D}$ = 3,640 kilog. (8,025 lb.).

Highest admissible speed : 32·2 kilometres (20·0 miles) per hour.

System of brakes steam and hand : acting on three pairs of wheels.

Steam heating : none.

Capacity for coal, 2·5 cubic metres (88·3 cubic feet); water, 4·5 cubic metres (990 English gallons).

When using pit coal which evaporates 6·49 times its weight of water train weighing 356 tons (349·6 English tons) gross on the flat is hauled at a speed of 24·6 kilometres (15·3 miles) per hour.

D. — Railways with a gauge of 785 millimetres (2 ft. 6 $^{29}/_{32}$ in.).

GERMANY.

1. — *Prussian State Railway, Kattowitz Directorate.*

Upper Silesian narrow-gauge lines.

Radius of sharpest curves on the open line : 40 metres (2 chains).

Radius of sharpest curves at switches : 35 metres (1 $^3/_4$ chains) where locomotives are used and 24 metres (1·2 chains) where they are not used.

Shortest straight between reverse curves : 10 metres (10·9 yards).

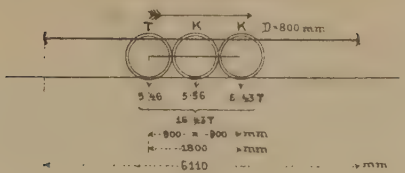
Steepest gradient considered : 40 per mil.

Year of purchase of locomotive : 1876 to 1880, 1884, 1888, 1890, 1891.

a) Tank locomotive supplied by Krauss in Munich and Hagans in Erfurt, of 2 very similar types; the more powerful is described.

Number : 39.

Arrangement of axles.



Heating surface :

Fire-box. . .	2·74 sq. metres	(29·94 sq. feet).
Smoke-tubes.	24 36	—	(262·22 —).
Total. . .	27·10 sq. metres	(292·16 sq. feet).

Grate area : 0·64 sq. metre (6·89 sq. feet).

Working pressure : $p = 12$ atmospheres.

Twin-working.

Dimensions of cylinders :

$d \times l = 280 \times 400$ millim. ($11'' \times 1'\,3\,3/4''$).

System of valve year : Stephenson with flat valves.

Theoretical tractive effort according to the formula $\frac{p \cdot d^2 \cdot l}{D} = 4{,}704$ kilog. (10,370 lb.)

Highest admissible speed : 25 kilometres (15·5 miles) per hour.

Sytem of brakes screw brake : Acting on two pairs of wheels.

Steam heating : none.

Capacity for coal, 1·35 cubic metres (47·7 cubic feet); water, 1·6 cubic metres (352 English gallons).

When using Upper Silesian coal train weighing 130 tons (127·9 English tons) gross, is hauled up a gradient of 13 per mil at a speed of 10 kilometres (6·2 miles) per hour.

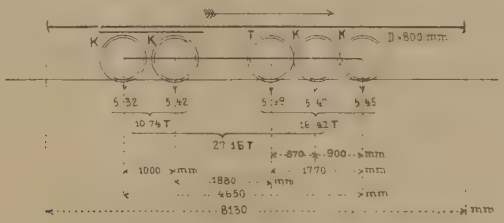
—

Year purchase of locomotive : 1898-1901.

b) Tank locomotive supplied by Hagans in Erfurt.

Number : 4.

Arrangement of axles.



Adjustability of axles : the coupled axles are in two motor bogies, on the Hagans system.

Heating surface :

Fire-box. . .	4·42 sq. metres	(47·58 sq. feet).
Smoke-tubes.	55·89	—	(601·61 —).
Total. . .	60 31 sq. metres	(649·19 sq. feet).

Grate area : 1·11 sq. metres (11·94 sq. feet).

Working pressure : $p = 12$ atmospheres.

Twin-working.

Dimensions of cylinders :

$d \times l = 350 \times 400$ millim. ($1'1\,3/4'' \times 1'\,3\,3/4''$).

System of valve year : Heusinger with fla valves.

Theoretical tractive effort according to the formula $\frac{p \cdot d^2 \cdot l}{D} = 7{,}350$ kilog. (16,204 lb.).

Highest admissible speed : 25 kilometres (15·5 miles) per hour.

System of brakes and brake : Acting on two pairs of wheels.

Steam heating : none.

Capacity for coal, 1·5 cubic metres (53 cubic

feet); water, 2·5 cubic metres (550 English gallons).

When using Upper Silesian coal train weighing 180 tons (177·2 English tons) gross, is hauled up a gradient of 13 per mil at a speed of 10 kilometres (6·2 miles) per hour.

—

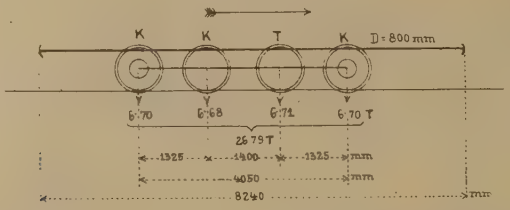
Year of purchase of locomotive : 1902.

c) Tank locomotive supplied by Hartmann, in Chemnitz.

Number : 2.

Adjustability of axles : First and fourth axle on the Klien-Lindner system. Middle axles fixed.

Arrangement of axles.



Heating surface :

Fire-box. . .	4·68	sq. metres	(50·37 sq. feet).
Smoke-tubes.	49·38	—	(531 54 —).
Total. . .	54·06	sq. metres	(581·91 sq. feet).

Grate area : 1·08 sq. metre (11.62 sq. feet).

Working pressure : $p = 12{\cdot}5$ atmospheres.

Twin-working.

Dimensions of cylinders :

$d \times l = 340 \times 400$ mill. ($1'\ 1\ ^3/_8'' \times 1'\ 3\ ^3/_4''$).

System of valve gear : Heusinger, with flat valves.

Theoretical tractive effort according of the formula $\frac{p \cdot d^2 \cdot l}{D} = 7{,}225$ kilog. (15,928 lb.)

Highest admissible speed : 25 kilometres (15.5 miles) per hour.

System of brakes hand brake automatic : Acting on two pairs of wheels.

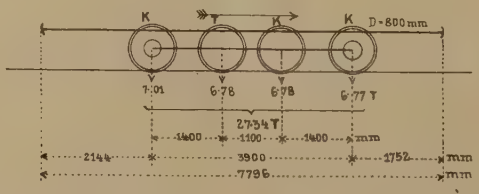
Steam heating : none.

Capacity for coal, 1·5 cubic metres (53 cubic feet); water, 2·5 cubic metres (550 English gallons).

When using upper Silesian coal, a train weighing 180 tons (177·1 English tons) gross, is hauled up a gradient of 13 per mil at a speed of 10 kilometres (6.2 miles) per hour.

—

Arrangement of axles.



Year of purchase of locomotive : 1904, 1905 and 1907.

d) Tank locomotive supplied by Orenstein & Koppel, A. G. in Drewitz-Berlin (fig. 11).

Number : 10.

Adjustability of axles : first and fourth axle on the Klien-Lindner system; in addition the middle axles have a lateral play of 20 millimetres ($^{25}/_{32}$ inch).

Heating surface :

Fire-box. . .	3·70 sq. metres	(39·82 sq. feet).
Smoke-tubes.	49·09	—	(528·41 —).
Total. . .	52·79 sq. metres	(568·23 sq. feet).

Grate area : 1·0 sq. metre (10·76 sq. feet).

Working pressure : $p = 13$ atmospheres.

Twin-working.

Dimensions of cylinders :

$d \times l = 340 \times 400$ mill. ($1' 1\ 3/8'' \times 1' 3\ 3/4''$).

System of valve gear : Heusinger, with flat valves.

Theoretical tractive effort according to the formula $\frac{p \cdot d^2 \cdot l}{D} = 7{,}514$ kilog. (16,565 lb.).

Highest admissible speed : 25 kilometres (15·5 miles) per hour.

System of brakes hand brake automatic : Acting on two pairs of wheels.

Steam heating : none.

Capacity for coal, 1·5 cubic metres (53 cubic feet); water, 2·5 cubic metres (550 English gallons).

When using upper Silesian coal, a train weighing 180 tons (177·1 English tons) gross, is hauled up a gradient of 13 per mil at a speed of 10 kilometres (6.2 miles) per hour.

E. — Railways with a gauge of 890 or 891 millimetres (2 ft. 11 3/64 in. or 2 ft. 11 5/64 in.)

SWEDEN.

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1. — *Swedish State Railway.*

Stockholm-Rimbo.

Radius of sharpest curves on the open line : 200 metres (10 chains).

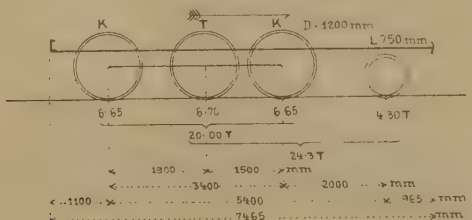
Radius of sharpest curves at switches : 125 metres (6 1/4 chains).

Year of purchase of locomotive : 1904 and 1906.

a) Tank locomotive supplied by « Vagn & Maskin Fabriks A. G. Fahlun » (fig. 12).

Number : 3.

Arrangement of axles.



Adjustability of axles : Bissel axle with lateral lay of 50 millimetres (2 inches) towards each side.

Heating surface :

Fire-box. . .	6·0 sq. metres	(64·58 sq. feet).
Smoke tubes.	54·5	—	(586·65 —).
Total. . .	60·5 sq. metres	(651·23 sq. feet).

Grate area : 0·9 sq. metre (9·68 sq. ft.)

Working pressure : $p = 12{\cdot}5$ atmospheres.

Compound working.

Dimensions of cylinders :

$d \times l = \frac{340}{510} \times 500$ mill. $\left(\frac{1'\,1\,3/8''}{1'\,8''} \times 1'\ 7\ 11/16''\right)$

System of valve gear : Heusinger, with flat valves.

Theoretical tractive effort according to the formula $0.75\ \frac{p \cdot d_h^2 \cdot l}{D} = 4{,}500$ kilog. (9,921 lb.).

Highest admissible speed : 60 kilometres (37·3 miles) per hour.

System of brakes New-York air brake automatic : acting on three pairs of wheels.

Capacity for coal, 2·0 cubic metres (70·6 cubic feet); water, 8·0 cubic metres (1,760 English gallons).

—

Stockholm-Rimbo and Dala-Ockelbo-Norrsundet.

Radius of sharpest curves on the open line : 148 metres (7·4 chains).

Radius of sharpest curves at switches : 119 metres (5·95 chains).

Shortest straight between reverse curves : 5·7 metres (6·2 yards).

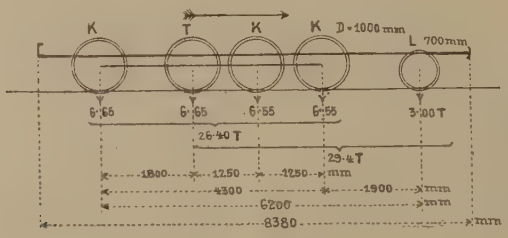
Steepest gradient considered : 27·6 per mil.

Year of purchase of locomotive : 1906.

b) Tank locomotive supplied by « Vagn & Maskin Fabriks A. B. Fahlun » (fig. 13).

Number : 4.

Arrangement of axles.



Adjustability of axles : the leading carrying axle has a lateral play of 50 millimetres (2 inches) on each side and the trailing coupled axle one of 15 millimetres ($^{19}/_{32}$ inch).

Heating surface :

Fire-box. . .	5·14 sq. metres	(55·32 sq. feet).
Smoke-tubes.	66·57	—	(716·58 —).
Total. . .	71·71 sq. metres	(771·90 sq. feet).

Grate area : 1·25 sq. metres (13·45 sq. feet).

Working pressure : $p = 12$ atmospheres.

Twin-working.

Dimensions of cylinders :

$d \times l = 340 \times 500$ mill. ($1' 1\,^3/_8'' \times 1' 7\,^{11}/_{16}''$).

System of valve gear : Heusinger, with flat valves.

Theoretical tractive effort according to the formula $\frac{p \cdot d^2 \cdot l}{D} = 6{,}940$ kilog. (15,300 lb.).

Highest admissible speed : 35 kilometres (21·7 miles) per hour.

System of brakes steam brake automatic : acting on three pairs of wheels.

Capacity for coal. 1·5 cubic metres (53 cubic feet); water, 5·2 cubic metres (1,145 English gallons).

—

Hvetlanda-Sässjö.

Radius of sharpest curves on the open line : 200 metres (10 chains).

Radius of sharpest curves at switches : 100 metres (5 chains).

Shortest straight between reverse curves : 15 metres (16·4 yards).

Steepest gradient considered : 20 per mil.

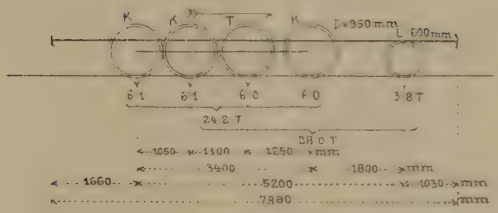
Year of purchase of locomotive : 1907.

c) Tank locomotive supplied by Motala, Werkstads Nya A. B. Motala.

Number : 1.

Adjustability of axles : the Bissel axle has a lateral play of 40 millimetres ($1\,^9/_{16}$ inches) and the trailing coupled axle one of 20 millimetres ($^{25}/_{32}$ inch).

Arrangement of axles.



Heating surface :

Fire-box . . .	5·57 sq. metres	(59·95 sq. feet).
Smokes-tubes.	47·17	—	(507·75 —).
Total. . .	52·74 sq. metres	(567·7 sq. feet).

Grate area : 0·9 sq. metre (9·68 sq. feet).

Working pressure : $p = 11$ atmospheres.

Twin-working.

Dimensions of cylinders :

$d \times l = 340 \times 460$ mill. ($1' 1\ 3/8'' \times 1' 6\ 1/8''$).

System of valve gear : Allan, with flat valves.

Theoretical tractive effort according to the formula $\frac{p \cdot d^2 \cdot l}{D} = 6{,}160$ kilog. (13,580 lb.).

System of brakes steam brake automatic : acting on three pairs of wheels.

Capacity for coal, 0·9 cubic metre (31·8 cubic feet); water, 2·9 cubic metres (638·3 English gallons).

Kinnekulle-Lidköping-Åkantorp.

Radius of sharpest curves on the open line : 190 metres (9 1/2 chains).

Radius of sharpest curves at switches : 150 metres (7 1/2 chains).

Shortest straight between reverse curves : 35 metres (38·3 yards).

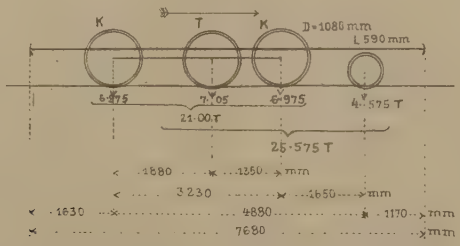
Steepest gradient considered : 16 per mil.

Year of purchase of locomotive : 1892, 1905 and 1908.

d) Tank locomotive supplied by Nydquist & Rohn, Trollhättan (fig. 15).

Number : 66.

Arrangement of axles.



Adjustability of axles : Bissel axle with a lateral play of 40 millimetres (1 9/16 inches).

Heating surface :

Fire-box . . .	5·1 sq. metres	(54·9 sq. feet).
Smokes-tubes.	45·7	—	(491·9 —).
Total. . .	50·8 sq. metres	(546·8 sq. feet).

Grate area : 0·8 square metre (8·61 sq. feet).

Working pressure : $p = 12$ atmospheres.

Twin-working.

Dimensions of cylinders :

$d \times l = 320 \times 450$ mill. ($1' 0\ 5/8'' \times 1' 5\ 11/16$).

System of valve year : Allan, with flat valves.

Theoretical tractive effort according to the

formula $\frac{p \cdot d^2 \cdot l}{D}$ = 5,110 kilog. (11,265 lb.).

Highest admissible speed : 50 kilometres (31 miles) per hour.

Steambrake automatic acting on two pairs of wheels.

Capacity for coal, 0·75 cubic metre (26·5 cubic feet); water, 3 cubic metres (660 English gallons).

When using hit coal giving 7·500 heat units (13,500 B.T.U. per lb.), which evaporates 7 times its weight of water 175 horse-power are developed and a train weighing, 160 tons (157·5 English tons) gross, is hauled up a gradient of 16 per mil at a speed of 25 kilometres (15·5 miles) per hour.

Uddevalla Lelängen.

Radius of sharpest curves on the open line : 180 metres (9 chains).

Radius of sharpest curves at switches : 140 metres (7 chains).

Shortest straight between reverse curves : 10 metres (10·9 yards).

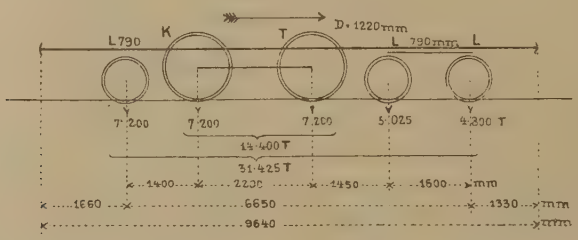
Steepest gradient considered : 16·67 per mil.

Year of purchase of locomotives : 1903.

e) Tank locomotive supplied by « Nydquist & Hohn », Trollhättan (figure 16).

Number : 8.

Arrangement of axles.



Adjustability of axles : one bogie and one Bissel truck.

Heating surface :

Fire-box . . .	6·25 sq. metres	(67·27 sq. ft.).
Smokes-tubes.	49·75 —	(535·52 —).
Total. . .	56·00 sq. metres	(602·79 sq. ft.).

Grate area : 0·90 square metre (9·68 sq. feet).

Working pressure : p = 11 atmospheres.

Twin-working.

Dimensions of cylinders :

$d \times l$ = 335 × 460 mill. (1′ 1 $^5/_{16}$″ × 1′ 6 $^1/_8$″).

System of valve gear : Allan, with flat valves.

Theoretical tractive effort according to the formula $\frac{p \quad d^2 \cdot l}{D}$ = 4,720 kilog. (10,406 lb.).

Highest admissible speed : 65 kilometres (40·4 miles) per hour.

System of brakes steam brake automatic : acting on two pairs of wheels.

Steam heating : none.

Capacity for coal, 1 cubic metre (35·3 cubic feet); water, 4 cubic metres (880 English gallons).

When using pit coal which evaporates 7 times its weight of water 195 horse-power are developed and a train weighing 140 tons (137·8 English tons) gross, is hauled up a gradient of 16 per mil at a speed of 30 kilometres (18·6 miles) per hour.

—

Norra-Östergötland.

Radius of sharpest curves ou the open line : 300 metres (15 chains).

Radius of sharpest curves at switches : 150 metres (7 $^1/_2$ chains).

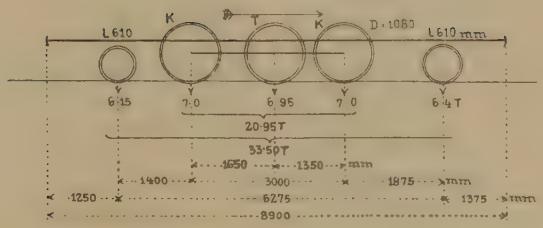
Steepest gradient considered : 16 per mil.

Year of purchasse of locomotive : 1908.

f) Tank locomotive supplied by « Nydquist & Hohn », Trollhättan.

Number : 4.

Arrangement of axles.



Adjustability of axles : two bissel trucks with a lateral play of 40 millimetres (1 $^{9}/_{16}$ inches).

Heating surface :

Fire-box . . .	6·04 sq. metres	(65·01 sq. feet).
Smoke-tubes .	53·99	—	(581·16 | —).
Superheater .	13·80	—	(148·54 | —).
Total. . .	73·83 sq. metres	(794·71 sq. feet).

Grate area : 0·9 sq. metre (9·68 sq. feet).

Working pressure : $p = 11$ atmospheres.

Temperature of steam : 300° C (572° Fahr.).

Twin-working.

Dimensions of cylinders :

$d \times l = 370 \times 460$ mill. ($1' 2\ ^{9}/_{16}'' \times 1' 6\ ^{1}/_{8}''$).

System of valve gear : Walschaerts, with Schmidt piston valves.

Theoretical tractive effort according to the formula $\frac{p \cdot d^2 \cdot l}{D} = 6{,}400$ kilog. (14.110 lb.).

Highest admissible speed : 50 kilometres (31 miles) per hour.

System of brakes steam brake automatic : acting on three pairs of wheels.

Capacity for coal, 1·25 cubic metre (44·1 cubic feet) ; water, 4·0 cubic metres (880 English gallons).

When using pit coal which evaporates 7 times its weight of water 250 horse-power are developed and a train weighing 200 tons (196·8 English tons) gross, is hauled up a gradient of 16 per mil at a speed of 30 kilometres (18·6 miles per hour.

—

Västergötland Göteborg.

Radius of sharpest curves on the open line : 200 metres (10 chains).

Radius of sharpest curves at switches : 150 metres (7 $^{1}/_{2}$ chains).

Shortest straight between reserve curves : 40 metres (43·7 yards).

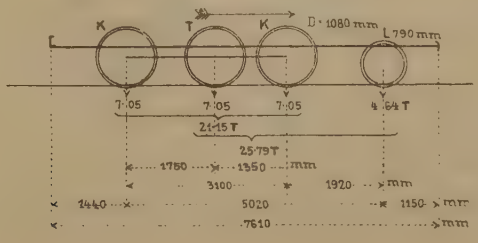
Steepest gradient considered 16·8 per mil.

Year of purchase of locomotive : 1901 to 1909.

g) Tank locomotive supplied by « Nydquist & Hohn », Trollhättan (fig. 17).

Number : 9.

Arrangement of axles.



Adjustability of axles : Bissel truck with a lateral play of 40 millimetres (1 $^{9}/_{16}$ inches).

Heating surface :

Fire-box. . .	5·65 sq. metres	(60·81 sq. feet).
Smoke-tubes.	49·70	—	(534·98 | — |).
Superheater.	11·20	—	(120·56 | — |).
Total . . .	66·55 sq. metres	(716·35 sq. feet).

Grate area : 1·1 sq. metres (11·84 sq. feet).

Working pressure : $p = 11$ atmospheres.

Temperature of steam 300° C. (572° Fahr).

Twin-working.

Dimensions of cylinders :

$d \times l = 370 \times 500$ mill. ($1' 2\,^{9}/_{16}'' \times 1' 7\,^{11}/_{16}''$).

System of valve gear : Walschaerts, with Schmidt piston valves.

Theoretical tractive effort according to the formula $\frac{p \cdot d^2 \cdot l}{D} = 6{,}950$ kilog. (15·322 lb.).

Highest admissible speed : 50 kilometres (31 miles) per hour.

System of brakes Hardy vacuum automatic : acting on three pairs of wheels.

Steam heating : none.

Capacity for coal, 2·0 cubic metres (70·6 cubic feet); water, 8·0 cubic metres (1,760 English gallons).

When using pit coal which evaporates 7 times ist weight of water 280 horse-power are developed and a train weighing 200 tons (196·8 English tons) gross, is hauled up a gradient of 16 per mil at a speed of 30 kilometres (18·6 miles) per hour.

---

2. — *Stockholm-Rimbo Yärnvägs A. B.*

Stockholm-Roslagen Railways.

Radius of sharpest curve on the open line : 200 metres (10 chains).

Radius of sharpest curves at switches : 125 metres ($6\,^{1}/_{4}$ chains).

Shortest straight between reserve curves : 35 metres (38·3 yards) between curves having radii of 300 and 400 metres (15 and 20 chains).

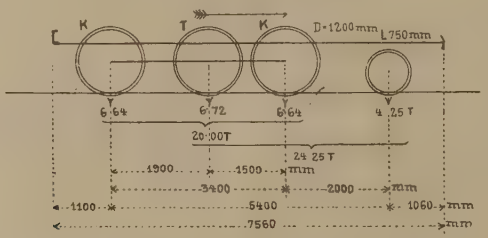
Steepest gradient considered : 20 per mil.

Year of purchase of locomotive : 1904 and 1906.

a) Tank locomotive supplied by « Vagn. & Maskin-Fabriks A. B. Fahlun ».

Number : 3.

Arrangement of axles.



Adjustability of axles : Bissel axle with a lateral play of 50 millimetres (2 inches).

Heating surface :

Fire-box . . .	6·5 sq. metres	(69 9 sq. feet).
Smoke-tubes .	54·0	—	(581·3 | — |).
Total. . .	60·5 sq. metres	(651·2	—	).

Grate area : 0·9 sq. metre (9·68 sq. feet).

Working pressure : $p = 12{\cdot}5$ atmospheres.

Compound-working.

Dimensions of cylinders :

$$d \times l = \frac{340}{510} \times 500 \text{ mill.} \left(\frac{1' 1\,^{3}/_{8}''}{1' 8''} \times 1' 7\,^{11}/_{16}'' \right)$$

System of valve gear : Heusinger von Waldegg, with flat valves.

Theoretical tractive effort according to the formula $0.75 \frac{p \cdot d^2 \cdot l}{D} = 4{,}560$ kilog. (10,053 lb.).

Highest admissible speed : 57 kilometres (35·4 miles) per hour.

System of brakes New York air brake automatic : acting on three pairs of wheels.

Capacity for coal, 2 cubic metre (70·6 cubic feet); water, 8 cubic metres (1,760 English gallons).

F. — Railways with a gauge of 914 millimetres (3 feet).

UNITED STATES OF AMERICA.

2. — *Chicago, Burlington and Quincy Railroad Company.*

This company operates about 120 kilometres (74 5 miles) of narrow-gauge road; it is used almost exclusively in serving various mines.

The service performed is mainly a switching service.

There are eight types of locomotives in use ; three of the 1 C type, one of the C type and four of the 1 D type.

Of these types, the chief particulars are given of one of the more powerful types of older design and of one of more recent design.

Radius of sharpest curves on the open line : 47 metres (2·35 chains).

Radius of sharpest curves at switches : 59 metres (2·95 chains).

Shortest straight between reverse curves : in some cases there in none.

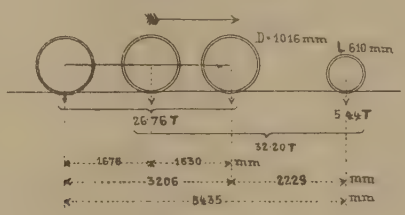
Steepest gradient considered : 82·5 per mil.

Year of purchase of locomotive : 1882.

a) Locomotive with separate tender supplied by Baldwin Works.

Number : 4.

Arrangement of axles.



Adjustability of axles : bissel truck, coupled axles with a lateral play of 4 millimetres ($^3/_{32}$ inch).

Heating surface :

Fire-box . . .	5·29 sq. metres	(56·9 sq. feet).
Smoke-tubes .	82·2 —	(884·8 —).
Total . . .	87·49 sq. metres	(941·7 sq. feet).

Grate area : 1·1 square metres (11·8 sq. feet).

Working pressure : $p = 10{\cdot}6$ atmospheres.

Twin working.

Dimensions of cylinders :

$d \times l = 381 \times 508$ millim. (1′ 3″ × 1′ 8″).

System of valve gear : Stephenson, with flat valves.

Theoretical tractive effort according to the formula $\frac{p \cdot d^2 \cdot l}{D} = 7{,}700$ kilog. (16,975 lb.).

System of brakes Westinghouse automatic : acting on three pairs of wheels.

Steam heating : none.

Capacity for coal, 5 cubic metres (176·6 cubic feet) ; water, 9·1 cubic metres (2,003 English gallons).

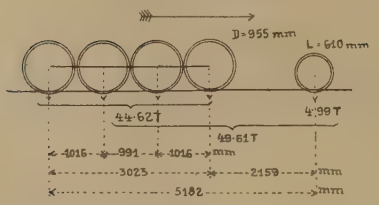
Newcastle-Wyoming bituminous pit coal used.

Year of purchase of locomotive : 1900.

Locomotive with separate tender supplied by Baldwin Works.

Number : 4.

Arrangement of axles.



Adjustability of axles: bissel truck, coupled axles with a lateral play of 4 millimetres ($^5/_{32}$ inch).

Heating surface:

Fire-box . .	7·61 sq. metres	(81·91 sq. feet.)
Smoke-tubes	126·8 —	(1,364·91 —).
Total . .	134·41 sq. metres	(1,446·82 sq. feet).

Grate area: 1·8 square metres (19·4 sq. feet).

Working pressure: $p = 12{\cdot}7$ atmospheres.

Twin working.

Dimensions of cylinders:

$d \times l = 432 \times 508$ millim. (1′ 5″ × 1′ 8″).

System of valve gear: Stephenson, with flat valves.

Theoretical tractive effort according to the formula $\frac{p \cdot d^2 \cdot l}{D} = 12{,}500$ kilog. (27,557 lb.).

System of brakes Westinghouse automatic: acting on fourth pairs of wheels.

Steam heating: none.

Capacity for coal, 3 cubic metres (106 cubic feet); water, 9·1 cubic metres (2,003 English gallons).

Newcastle-Wyoming bituminous pit coal is used.

—

3. — *Pennsylvania Lines West of Pittsburgh.*

Waynesburg & Washington Railroad.

Radius of sharpest curves on the open line: 53·5 metres (2·675 chains).

Radius of sharpest curves at switches: 89·7 metres (4,485 chains).

Shortest straight between reverse curves: 18 6 metres (20·3 yards) between curves with radii of 57 and 87·6 metres (2·85 and 4·38 chains.)

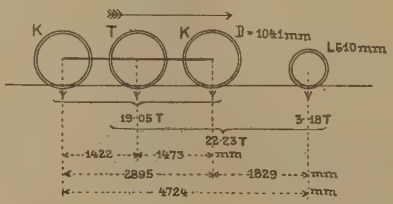
Steepest gradient considered: 25·6 per mil).

Year of purchase of locomotive: 1889 to 1903.

Locomotive with separate tender supplied by American Locomotive Co., Pittsburgh Works (figs. 18 and 19).

Number: 6.

Arrangement of axles.



Adjustability of axles: bissel axle, no mechanical restriction; coupled axles with a lateral play of 14 millimetres ($^9/_{16}$ inch).

Heating surface:

Fire-box . . .	5·57 sq. metres	(59·95 sq. feet).
Smoke-tubes.	40·9 —	(440·26 —).
Total. .	46·47 sq. metres	(500·21 sq. feet).

Grate area : 0·75 square metre (8·07 sq. feet).

Working pressure : $p = 10·6$ atmospheres.

Twin working.

Dimensions of cylinders :

$d \times l = 305 \times 508$ millim. ($1' \times 1'\ 8''$).

System of valve gear : Link motion, with Allen balanced valves.

Theoretical tractive effort according to the formula $\frac{p \cdot d^2 \cdot l}{D} = 4{,}810$ kilog. (10,582 lb.).

Highest admissible speed : 48·2 kilometres (29·9 miles).

System of brakes vacuum non-automatic : acting on two pairs of wheels.

Capacity for coal, 4 cubic metres (141 cubic feet; water, 7·3 cubic metres (1,607 English gallons).

When using pit coal a train weighing 112 tons (110·2 English tons) gross, is hauled up a gradient of 25·6 per mil at a speed of 9·65 kilometres (6 miles) per hour.

G. — Railway with a gauge of 950 millimetres (2 ft. 11 1/2 in.).

ITALY.

1. — *Italian State Railway.*

Radius of sharpest curves on the open line : 100 metres (5 chains).

Shortest straight between reverse curves : 60 metres (65·6 yards)

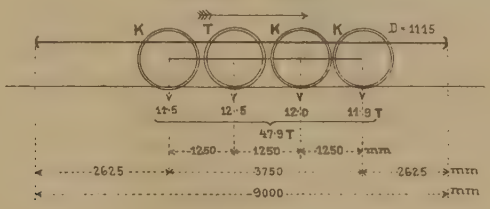
Steepest gradient considered : 25 per mil.

Year of purchase of locomotive : 1909.

Tank locomotive supplied by Schwarzkopf in Berlin.

Number : 12.

Arrangement of axles.



Heating surface :

Fire-box. . .	5·8 sq. metres	(62·43 sq. feet).
Smoke-tubes.	99·6 —	(1,072·12 sq. feet).
Total. . .	105·4 sq. metres	(1,134·55 sq. feet).

Grate area : 1·5 sq. metres (16·14 sq. feet).

Working pressure : $p = 14$ atmospheres.

Smoke consumer : Arch and screen in fire-box.

Twin working.

Dimensions of cylinders :

$d \times l = 410 \times 520$ millim. ($1'\ 4\ 1/8'' \times 1'\ 8\ 1/2$).

System of valve gear Walschaerts with flat valves.

Theoretical tractive effort according to the formula $\frac{p \cdot d^2 \cdot l}{D} = 11{,}070$ kilog. (25,790 lb.).

System of brakes vacuum automatic : acting on four pairs of wheels.

Capacity for coal 2 cubic metres (70·6 cubic feet); water, 5 cubic metres (1,100 English gallons).

Intended for Newport and Cardiff coal.

H. — Railways with a gauge 1,000 millimetres (3 ft. 3 3/8 in.).

GERMANY.

1. — *Alsace-Lorraine Railway.*

Radius of sharpest curves on the open line : 50 metres (2 1/2 chains).

Radius of sharpest curves at switches : 70 and 57 metres (3·50 and 2·85 chains).

Shortest straight between reverse curves : 2·26 metres (2·47 yards) between curves having a radius of 60 metres (65·6 yards).

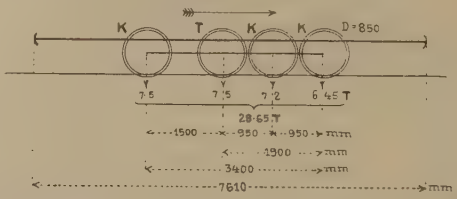
Steepest gradient considered 33 per mil.

Year of purchase of locomotive : 1903 to 1908.

b) Tank locomotive supplied by Hagans in Erfurt.

Number : 10.

Arrangement of axles.



Adjustability of axles : The trailing axle is in a Bissel truck and actuated by a loose shaft.

Heating surface :

Fire-box. . .	3·64 sq. metres	(39·18 sq. feet).
Smoke-tubes.	47·13 —	(507·32 —).
Total. . .	50·77 sq. metres	(546·50 sq. feet).

Grate area : 0·938 sq. metre (10·096 sq. feet).

Working pressure : $p = 12$ atmospheres.

Twin-working.

Dimensions of cylinders :

$d \times l = 350 \times 400$ mill. ($1'1\,^{25}/_{32}'' \times 1'3\,^{3}/_{4}''$).

System of valve year : Heusinger with flat valves.

Theoretical tractive effort according to the formula $\frac{p \cdot d^2 \cdot l}{D} =$ 6,920 kilog. (15,256 lb.).

Highest admissible speed : 30 kilometres (18·6 miles).

System of brakes hand brake : acting on three pairs of wheels.

Capacity for coal 1 cubic metre (35·3 cubic feet); water, 3 cubic metres (660 English gallons).

When using pit coal giving 7,100 heat units (12,780 B. T. U. per lb.) which evaporates 5·5 to 6 times its weight of water, train weighing 70 to 80 tons (68·9 to 78·7 English tons) gross, is hauled up a gradient of 33 per mil at a speed of 15 to 12 kilometres (9·3 to 7·4 miles) per hour.

—

2. — *Bavarian State Railway.*

Neuötting-Altötting.

Radius of sharpest curves on the open line : 21 metres (1·05 chains).

Radius of sharpest curves at switches : 53 metres (2·65 chains) with grooved rails, otherwise 75 metres (3 ¾ chains).

Shortest straight between reverse curves 6 metres (6·6 yards) between curves having radii of 30 and 70 metres (1 ½ and 3 ½ chains).

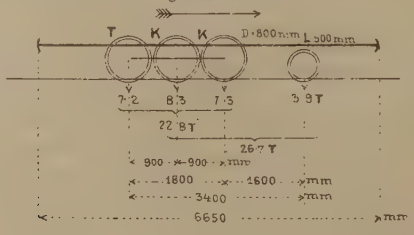
Steepest gradient considered 58·82 per mil.

Year of purchase of locomotive : 1906.

a) Tank locomotive supplied by Krauss & C°, Munich.

Number : 3.

Arrangement of axles.



Adjustability of axles : carrying axle in bissel truck with lateral play of 130 millimetres (5 1/8 inches) in each side; the third coupled axle has a play of 50 millimetres (2 inches).

Heating surface :

Fire-box. . .	4·25 sq. metres	(45·74 sq. feet).
Smoke-tubes.	32·38	—	(384·54 | —).
Superheater.	9·2	—	(99·03 | —).
Total. . .	45·83 sq. metres	(493·31 sq. feet).

Grate area : 0·79 sq. metre (8·50 sq. feet).

Working pressure : $p = 12$ atmospheres.

Twin working.

Dimensions of cylinders :

$d \times l = 380 \times 340$ millim. ($1' 3'' \times 1' 1\ 3/8''$).

System of valve gear : Heusinger with piston valves.

Theoretical tractive effort according to the formula $\frac{p \cdot d^2 \cdot l}{D} = 7{,}364$ kilog. (16,235 lb.).

Highest admissible speed : 30 kilometres (18·6 miles).

System of brakes : Westinghouse automatic, acting on two pairs of wheels.

Capacity for coal 0·6 cubic metre (21·2 cubic feet); water, 2·5 cubic metres (550 English gallons).

When using briquettes from the Ruhr district giving 7,500 heat units (12,500 B. T. U. per lb.); 150 horse-power are developed and a train weighing 14 to 16 tons (13·8 to 15·7 English tons) gross, is hauled up a gradient of 48·1 per mil at a speed of 14 to 10 kilometres (8·7 to 6·2 miles) per hour.

—

3. — *Erfurt directorate.*

Radius of sharpest curves on the open line : 40 metres (2 chains).

Radius of sharpest curves at switches : 75 metres (3 3/4 chains).

Shortest straight between reverse curves : 11 metres (12 yards) between curves having radii of 70 and 150 metres (3 1/2 and 7 1/2 chains).

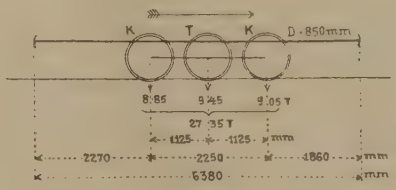
Steepest gradient considered : 33·3 per mil.

Year of purchase of locomotive : 1908.

Tank locomotive supplied by Ch. Hagans in Erfurt (fig. 20).

Number : 2.

Arrangement of axles.



Heating surface :

Fire-box. . .	3·81 sq. metres	(41·01 sq. feet).
Smoke-tubes.	47·21	—	(508·18 | —).
Total. . .	51·02	—	(549·19 | —).

Grate area : 0·857 sq. metre (9·225 sq. feet).

Working pressure : $p = 12$ atmospheres.

Twin working.

Dimensions of cylinders :

$d \times l = 350 \times 400$ millim. ($1' 1\ 25/32'' \times 1' 3\ 3/4''$).

System of valve gear : Heusinger with flat valves.

Theoretical tractive effort according to the formula $\frac{p \cdot d^2 \cdot l}{D} = 6{,}918$ kilog. (15,252 lb.).

Highest admissible speed : 30 kilometres (18·6 miles).

System of brakes Schleifer : acting on three pairs of wheels.

Capacity for coal, 1 cubic metre (35·3 cubic feet); water, 3·1 cubic metres (682 English gallons).

When using Ruhr coal, 189 horse-power

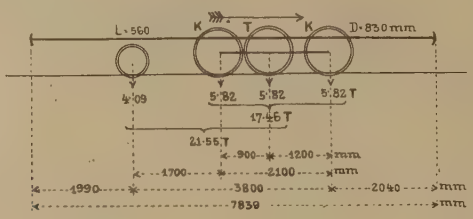
are developed and a train weighing 64 tons (62·9 English tons) gross, is hauled up a gradient of 25 per mil at a speed of 15 kilometres (9·3 miles) per hour.

Year of purchase of locomotive : 1899.

b) Tank locomotive supplied by Krauss & C°, Munich (fig. 21).

Number : 1.

Arrangement of axles.



Adjustability of axles : Carrying axle in Bissel truck with play of 20 millimetres ($^{13}/_{16}$ inch).

Heating surface :

Fire-box. . .	3·53 sq. metres	(37·99 sq. feet).
Smoke-tubes.	33·15 —	(356·83 —).
Total. . .	36·68 sq. metres	(394·82 sq feet).

Grate area : 0·65 sq. metre (6·99 sq. feet).

Working pressure : $p = 12$ atmospheres.

Twin working.

Dimensions of cylinders :

$d \times l = 300 \times 400$ mill. ($11\,^7/_8'' \times 1'\,3\,^3/_8''$).

System of valve gear : Heusinger with flat valves.

Theoretical tractive effort according to the formula $\frac{p \cdot d^2 \cdot l}{D} = 5{,}205$ kilog. (11,457 lb.).

Highest admissible speed : 30 kilometres (18·6 miles).

System of brakes Schleifer : acting on two pairs of wheels.

Capacity for coal, 0·76 cubic metre (26·8 cubic feet); water, 2·1 cubic metres (462 English gallons).

When using Ruhr coal, lumps and briquettes, 146 horse-power are developed and a train weighing 64 tons (62·9 English tons) gross, is hauled up a gradient of 25 per mil at a speed of 10 kilometres (6·2 miles) per hour.

—

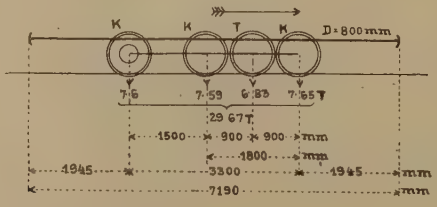
Year of purchase of locomotive : 1902.

c) Tank locomotive supplied by Ch. Hagans in Erfurt (fig. 22).

Number : 1.

Adjustability of axles : 4th axle is of the hollow-axle type.

Arrangement of axles.



Heating surface :

Fire-box. . . 3·64 sq. metres (39·18 sq. feet).
Smoke-tubes. 47·13 — (507·32 —).

Total. . . 50·77 sq. metres (546·60 sq. feet).

Grate area : 0·94 sq. metre (10·11 sq. feet).

Working pressure : $p = 12$ atmospheres.

Twin working.

Dimensions of cylinders :

$d \times l = 320 \times 400$ millim. ($1'\,^{19}/_{32}'' \times 1'\,3\,^{3}/_{4}''$).

System of valve gear : Heusinger, with flat valves.

Theoretical tractive effort according to the formula $\frac{p \cdot d^2 \cdot l}{D} = 6,144$ kilog. (13,545 lb.).

Highest admissible speed : 30 kilometres (18·6 miles).

System of brakes Schleifer : acting on three pairs of wheels.

Capacity for coal, 1 cubic metre (35·3 cubic feet); water, 3 cubic metres (660 Engl. gallons).

When using Ruhr coal, lumps and briquettes, 200 horse-power are developed and a train weighing 64 tons (62·9 English tons) gross, is hauled up a gradient of 25 per mil at a speed of 15 kilometres (9·3 miles) per hour.

—

4. — *Saxon State Railway.*

Radius of sharpest curves on the open line : 30 metres ($1\,^{1}/_{2}$ chains).

Radius of sharpest curves at switches : 25 metres ($1\,^{1}/_{4}$ chains).

Shortest straight between reverse curves : 10 metres (10·9 yards).

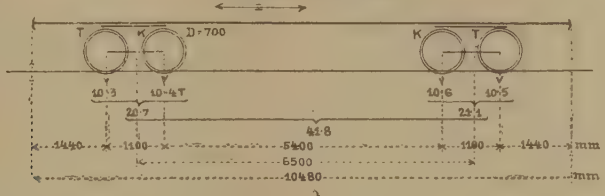
Steepest gradient considered : 25 per mil.

Year of purchase of locomotive : 1902.

Tank locomotive supplied by R. Hartmann, Chemnitz in Saxony (fig. 23).

Number : 3.

Arrangement of axles.



Adjustability of axles : Each pair of axles in a motor bogie of the Fairlie type.

Heating surface :

Fire-box. . . 7·77 sq. metres (83·63 sq. feet).
Smoke-tubes. 71·28 — (767·27 —).

Total. . . 79·05 sq. metres (850·91 sq. feet).

Grate area : 1·89 sq. metres (20·34 sq. feet).

Working-pressure : $p = 14$ atmospheres.

Compound-working.

Dimensions of cylinders :

$d \times l = \frac{2 \times 280}{2 \times 430} \times 380$ mill. $\left(\frac{2 \times 11'}{2 \times 1'5''} \times 1'3''\right)$.

System of valve gear : Heusinger, with flat valves, with Trick port.

Theoretical tractive effort according to the formula $1{\cdot}5\frac{p \cdot d_h^2 \cdot l}{D} = 8,232$ kilog. (18,148 lb.)

Highest admissible speed : 30 kilometres (18·6 miles).

System of brakes Brake : acting on two pairs of wheels.

Capacity for coal, 1·6 cubic metres (56·5 cubic feet); water, 3·2 cubic metres (704 English gallons).

—

5. — *Wurtemberg State Railway.*

Radius of sharpest curves on the open line : 80 metres (4 chains).

Radius of sharpest curves at switches : 70 metres ($3\,^{1}/_{2}$ chains).

*

Shortest straight between reverse curves : 5·4 metres (5·9 yards) between curves having radii of 475 and 378 metres (23 3/4 and 18·9 chains).

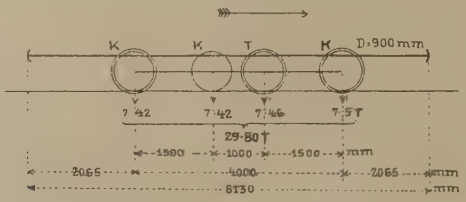
Steepest gradient considered : 40 per mil.

Year of purchase of locomotive : 1891 to 1899.

Tank locomotive supplied by the Maschinenfabrik, Esslingen (fig. 24).

Number : 3.

Arrangement of axles.



Adjustability of axles : first and fourth axle radially adjustable, on the Klose system, third axle has wheels without flanges.

Heating surface :

Fire-box. . .	5·42 sq. metres	(58·34 sq. feet).
Smoke-tubes.	65·20 —	(701·83 —).
Total. . .	70·62 sq. metres	(760·17 sq. feet).

Grate area : 1·02 sq. metres (10·97 sq. feet).

Working pressure : $p = 12$ atmospheres.

Twin working.

Dimensions of cylinders :

$d \times l = 340 \times 500$ millim. ($1' 1\,3/8'' \times 1' 7\,11/16''$).

System of valve gear : (Joy) Klose, with flat valves with Trick port.

Theoretical tractive effort according to the formula $\frac{p \cdot d^2 \cdot l}{D} = 7{,}800$ kilog. (17,196 lb.).

Highest admissible speed : 30 kilometres (18·6 miles).

System of brakes : Westinghouse automatic : acting on one pair of wheels.

Steam heating.

Capacity for coal, 0·75 cubic metre (26·5 cubic feet) ; water, 2·4 cubic metres (528 Engl. gallons).

When using pit coal, Saar and Ruhr, mixed in equal parts which evaporates 7 to 7·5 times its weight of water, 190 horse-power are developed and a train weighing 50 tons (49·2 English tons) gross, is hauled up a gradient of 40 per mil at a speed of 15 kilometres (9·3 miles) per hour.

—

ARGENTINE REPUBLIC.

6. — *Argentine Northern Railway.*

Radius of sharpest curves on the open line : 450 metres (22 1/2 chains).

Radius of sharpest curves at switches : 180 metres (9 chains).

Shortest straight between reverse curves : 500 metres (547 yards).

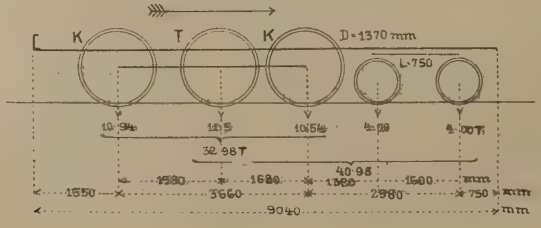
Steepest gradient considered : 12 per mil.

Year of purchase of locomotive : 1905.

a) Locomotive with separate tender supplied by Borsig.

Number : 9.

Arrangement of axles.



Adjustability of axles : carrying axles in a bogie.

Fire-box . . 11.26 sq. metres (121·20 sq. feet).
Smoke-tubes 108·70 ' — (1,170·08 —).

Total . . 119·96 sq. metres (1,291·28 sq. feet).

Grate area 1·5 square metres (16·14 sq. feet).

Working pressure : $p = 12$ atmospheres.

Twin working.

Dimensions of cylinders :

$d \times l = 430 \times 610$ millim. (1′ 5″ × 2″).

System of valve gear : Stephenson, with piston valves.

Theoretical tractive effort according to the formula $\frac{p \cdot d^2 \cdot l}{D} = 9{,}880$ kilog. (21,782 lb.).

System of brakes vacuum automatic : acting on two pairs of wheels.

Capacity for wood, 10 cubic metres (353 cubic feet) ; water, 15 metres cubes (3,300 English gallons).

When using wood a train weighing 340 tons (335 English tons) gross, is hauled up a gradient of 10 per mil at a speed of 25 kilometres (15·5 miles) per hour.

—

FRANCE.

8. — *Orleans Railway.*

Coreze line.

Radius of sharpest curves on the open line : 100 metres (5 chains).

Radius of sharpest curves at switches : 107·35 metres (5·37 chains).

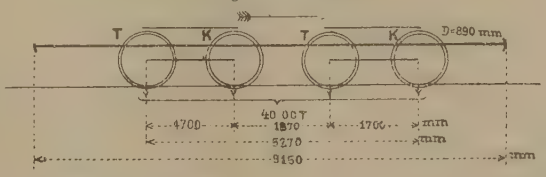
Shortest straight between reverse curves : 40 metres (43·7 yards).

Steepest gradient considered : 30 per mil.

Year of purchase of locomotive : 1905 to 1906.

c_2) Tank locomotive (fig. 25).

Arrangement of axles.



Adjustability of axles : each pair of axles is in a bogie of the Mallet type.

Heating surface :

Fire-box. . . 6·00 sq. metres (64·58 sq. feet).
Smoke-tubes. 72·00 — (775·02 —).

Total. . . 78·00 sq. metres (839·60 sq. feet).

Grate area : 1·57 sq. metres (16.89 sq. feet).

Working pressure : $p = 14$ atmospheres.

Working compound in fourth.

Dimensions of cylinders :

$$d \times l = \frac{2 \times 300}{2 \times 460} \times 460 \text{ mill.} \left(\frac{2 \times 11\ 7/8''}{2 \times 1'6''} \times 1'6'' \right).$$

System of valve gear : Walschaerts with flat valves.

Theoretical tractive effort according to the formula $1{\cdot}5\ p \cdot \frac{d_h^2 \cdot l}{D} = 9{,}768$ kilog. (21,535 lb.).

Highest admissible speed ; 40 kilometres (24·8 miles) per hour.

System of brakes vacuum automatic : Acting on fourth pairs of wheels.

Steam heating : none.

Capacity for coal, 1·2 cubic metres (42·4 cubic feet) ; water, 3·0 cubic metres (660 English gallons).

When using pit and pea-coal from Decazeville, train weighing 110 tons gross (108·2 English tons), is hauled up a gradient of 30 per mil at a speed of 18 kilometres (11·2 miles) per hour.

10. — *Aisne Department Railway.*

Tramway.

Radius of sharpest curves on the open line : 40 metres (2 chains).

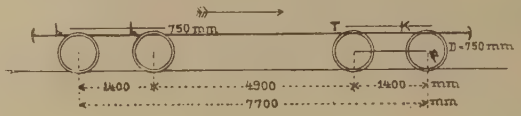
Radius of sharpest curves at switches : 40 metres (2 chains).

Steepest gradient considered : 44 per mil.

b) Year of purchase of automotor cars : 1907, supplied by Pinguely.

Number : 3.

Arrangement of axles.



Adjustability of axles : each pair of axles in one bogie.

Heating surface, total : 20·44 sq. metres (220·02 sq. feet).

Grate area : 0·44 sq. metre (4·73 sq. feet).

Working pressure : $p = 12{\cdot}1$ atmospheres.

Twin-working.

Dimensions of cylinders :

$d \times l = 230 \times 300$ millim. (9″ × 11 $^{7}/_{8}$″).

System of valve gear : Walschaerts, with flat valves.

Theoretical tractive effort according to the formula $\frac{p \cdot d^2 \cdot l}{D} = 2{,}540$ kilog. (5,600 lb.).

System of brakes compressed air : acting on fourth pairs of wheels.

Capacity for coal, 0·43 cubic metre (15·18 cubic feet) ; water, 2·9 cubic metres (638 English gallons).

Coal from Mariemont is used.

—

PORTUGAL.

13. — *National Railway Company.*

Radius of sharpest curves on the open line : 150 metres (7 $^{1}/_{2}$ chains).

Radius of sharpest curves at switches : 100 metres (5 chains).

Shortest straight between reverse curves : 50 metres (54·7 yards).

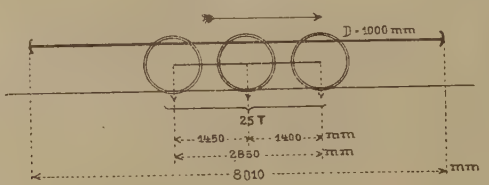
Steepest gradient considered : 18 per mil.

Year of purchase of locomotive : 1888.

b) Tank locomotive, supplied by the Maschinenfabrik Esslingen.

Number : 6.

Arrangement of axles.



Heating surface :

Fire-box. . .	6·00 sq. metres	(64·58 sq. feet).
Smoke-tubes.	64·00	—	(668·91 | — |).
Total. . .	70·00 sq. metres	(753·49	—	).

Grate area : 0·88 sq. metre (9·47 sq. feet).

Working pressure : $p = 10$ atmospheres.

Twin-working.

Dimensions of cylinders :

$d \times l = 350 \times 500$ mill. (1′ 1 $^{13}/_{16}$″ × 1′ 7 $^{11}/_{16}$″).

Theoretical tractive effort according to the formula $\frac{p \cdot d^2 \cdot l}{D} = 6{,}120$ kilog. (13,492 lb.).

Highest admissible speed : 45 kilometres (27·9 miles) per hour.

System of brakes Clayton vacuum automatic : acting on three pairs of wheels.

Capacity for coal, 0·8 cubic metre (28·2 cubic feet) : water, 3·0 cubic metres (660 English gallons).

Cardiff coal is used.

—

RUSSIA.

14. — *Riazan-Ural Railway.*

Urbach Ural, 346 kilometres (215 miles), Erschoff-Nicolajevsk, 94 kilometres (58·4 miles), Krasnyikut-Alexandrov 152 kilometres (94 miles), total, 592 kilometres (367·4 miles).

Radius of sharpest curves on the open line : 426 metres (21·3 chains).

Shortest straight between reverse curves : 0 metre.

Steepest gradient considered : 8 per mil.

Year of purchase of locomotive : 1894.

a) Locomotive with separate tender (fig. 27), supplied by Baldwin-Works.

Number : 4.

Adjustability of axles : carrying axle in a bissel truck.

Heating surface :

Fire-box. . .	4·59 sq. metres	(49·41 sq. feet).
Smoke-tubes.	37·22 —	(400·64 —).
Total. . .	41·81 sq. metres	(450·05 sq. feet).

Grate area : 0·87 sq. metre (9·36 sq. feet).

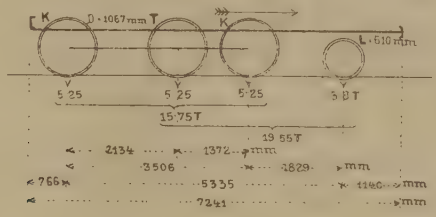
Working pressure : $p = 8$ atmospheres.

Twin working.

Dimensions of cylinders :

$d \times l = 305 \times 406$ millimetres (1′ × 1′ 4″).

Arrangement of axles.



System of valve gear : Stephenson with Adams valves.

Theoretical tractive effort according to the formula $\frac{p \cdot d^2 \cdot l}{D} = 2{,}840$ kilog. (6,261 lb.).

Highest admissible speed : 37·5 kilometres (23·3 miles) per hour.

System of brakes Hardy automatic : acting on the tender pairs of wheels.

Capacity for coal : naphta, 3·5 cubic metres (123·6 cubic feet); water, 7·5 cubic metres (1,650 gallons).

Naphta giving 10,800 heat units (19,440 B. T. U. per lb.) is used.

—

SWITZERLAND.

16. — *Rhetian Railway.*

Radius of sharpest curve on the open line : 100 metres (5 chains).

Radius of sharpest curves at switches : 90 metres (4 1/2 chains).

Shortest straight between reverse curves : 10 metres (10·9 yards) between parabolic transition curves.

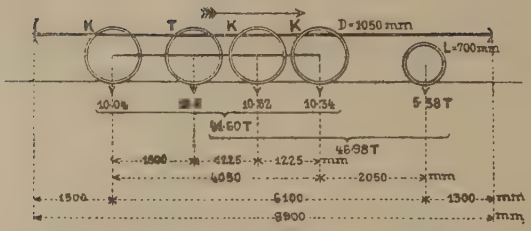
Steepest gradient considered : 45 per mil.

Year of purchase of locomotive : 1906 to 1909.

Locomotive with separate tender supplied by the Schweizerische Locomotivfabrik Winterthur.

Number : 11.

Arrangement of axles.



Adjustability of axles : carrying axle in bissel truck with play of 75 millimetres (3 inches); lateral play of coupled axles, 25 to 32 millimetres (1 inch to 1 $^{9}/_{32}$ inches).

Heating surface :

Fire-box . .	8·4 sq. metres	(90·42 sq. feet).
Smoke-tubes.	97·1	—	(1,045·21 | — |).
Superheater.	27·5	—	(296·01 | — |).
Total . .	133·0 sq. metres	(1,431·64 sq. feet).

Grate area : 2·1 sq. metres (22·60 sq. feet).

Working pressure : $p = 12$ atmospheres.

Smoke consumer Langer.

Twin working.

Dimensions of cylinders :

$d \times l = 460 \times 580$ millim. (1′ 6″ × 1′ 10 $^{7}/_{8}$″)

System of valve gear : Heusinger, with piston valves.

Theoretical tractive effort according to the formula $\frac{p \cdot d^2 \cdot l}{D} = 14{,}000$ kilog. (30,865 lb.).

Highest admissible speed : 45 kilometres (27·9 miles) per hour.

System of brakes Hardy vacuum automatic : acting on two pairs of wheels.

Capacity for coal : 2·5 cubic metres (88·3 cubic feet) ; water 10 cubic metres (2·200 English gallons).

When using German and Belgian briquettes coal a train weighing 100 tons (98·4 English tons) gross, is hauled up a gradient of 35 per mil at a speed of 18 kilometres (11·2 miles) per hour.

I. — Railway with a gauge of 1,067 millimetres (3 ft. 6 in.).

BELGIUM.

1. — *Belgian National Suburban Railway Company.*

Locomotives of these types are constructed both for lines with a gauge of 1,000 millimetres and one of 1,067 millimetres (3 ft. 3 $^{3}/_{8}$ in. and 3 ft. 6 in.).

Radius of sharpest curves on the open line : 25 metres (1 $^{1}/_{4}$ chains).

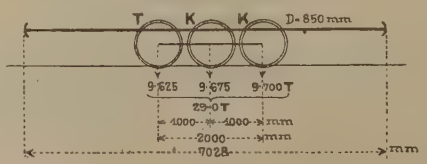
Steepest gradient considered : 70 per mil.

Year of purchasse of locomotives since 1884 of two similar types, of which the more powerful is given here.

Tank locomotive supplied by several Belgian locomotive works.

Number : 561.

Arrangement of axles.



Heating surface :

Fire-box. . .	6·10 sq. metres	(65·60 sq. feet).
Smoke-tubes.	42·02 —	(452·31 —).
Total. . .	48·12 sq. metres	(517·91 sq. feet).

Grate area : 0·945 sq. metre (10·172 sq. feet).

Working pressure : $p = 12$ atmospheres.

Twin working.

System of valve gear : Walschaerts, with flat valves and ports.

Theoretical tractive effort according to the formula $\frac{p \cdot d^2 \cdot l}{D} = 2{,}205$ kilog. (4,861 lb.).

Highest admissible speed : 35 to 40 kilometres (21·7 to 24 8 miles) per hour.

System of brakes Handbrake : acting on two pairs of wheels.

Capacity for coal, 0·65 cubic metre (22·95 cubic feet); water, 1 cubic metre (220 English gallons).

When using Belgian pit coal which evaporates 8 times its weight of water, 118 horsepower are developed at a speed of 30 kilometres (18·6 miles) per hour.

NORWAY.

2. — *Norwegian State Railway.*

Radius of sharpest curves on the open line : 188 metres (9·4 chains).

Radius of sharpest curves at switches : 100 metres (5 chains).

Shortest straight between reverse curves : is not prescribed.

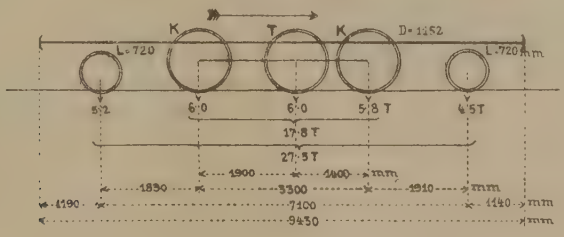
Steepest gradient considered : 23·8 per mil.

Year of purchase of locomotive : 1895 to 1908.

b) Tank locomotive.

Number : 6.

Arrangement of axles.



Adjustability of axles : leading axle in Bissel truck, play 70 millimetres (2 3/4 inches).

Heating surface :

Fire-box. . .	5·21 sq. metres	(56 08 sq. feet).
Smoke-tubes.	40 95 —	(440·79 —).
Total. . .	46·16 sq. metres	(496·87 sq. feet).

Grate area : 0·85 sq. metre (9·14 sq. feet).

Working pressure : $p = 10$ atmospheres.

Twin working.

Dimensions of cylinders :

$d \times l = 330 \times 460$ millim. (1′ 1″ × 1′ 6″).

System of valve gear : Heusinger.

Theoretical tractive effort according to the formula $\frac{p \cdot d^2 \cdot l}{D} = 4{,}400$ kilog. (9,700 lb.).

Highest admissible speed : 55 kilometres (34·2 miles) per hour.

System of brakes compressed air automatic : acting on two pairs of wheels.

Steam heating : none.

Capacity for coal, 0·8 cubic metre (28·3 cubic feet) ; water, 2·2 cubic metres (484 English gallons).

RUSSIA.

3. — *Moscow-Windau-Rybinsk Railway.*

Radius of sharpest curves on the open line : 322 metres (16·1 chains).

Radius of sharpest curves at switches : 178 metres (8·9 chains).

Shortest straight between reverse curves : 313 metres (342 yards) between curves with radii of 639 and 958 metres (31·95 and 47·9 chains).

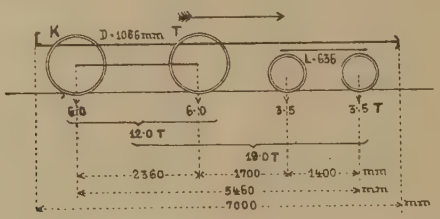
Steepest gradient considered : 6·6 per mil.

Year of purchase of locomotive : 1871 to 1878.

a) Locomotive with separate tender of three similar types, of which the most powerful is given here supplied by Evanseid, Doubs and Schwarzkopf.

Number : 9.

Arrangement of axles.



Adjustability of axles : Two carrying in a bogie.

Heating surface :

Fire-box . . .	5·30 sq. metres	(57·05 sq. feet).
Smoke-tubes .	40 —	(430 57 —).
Total. . .	45·30 sq. metres	(487·62 sq. feet).

Grate area : 1 sq. metre (10·76 sq. feet).

Working pressure : $p = 10$ atmospheres.

Twin working.

Dimensions of cylinders :

$d \times l = 254 \times 458$ mill. (10″ × 1′ 6″).

System of valve gear : Allan with flat valves.

Theoretical tractive effort according of the formula $\frac{p \cdot d^2 \cdot l}{D} = 2{,}770$ kilog. (6,107 lb.).

Highest admissible speed : 50 kilometres (31 miles) per hour.

Capacity for wood, 4·86 cubic metres (171·64 cubic feet) ; water 4·47 cubic metres (983 English gallons).

APPENDIX II.

1. — List of the administrations who sent answers to the list of questions relating to the first supplement of subject XIX, littera A.

GERMANY.

1. — Alsace-Lorraine Railway.
2. — Bavarian State Railway.
3. — Prussian-Hessian State Railway, Erfurt Directorate.
4. — Prussian-Hessian Sate Railway, Kattowitz Directorate.
5. — Saxon State Railway.
6. — Wurtemberg State Railway.

ARGENTINE REPUBLIC.

7. — Argentine Northern Railway.

AUSTRIA AND HUNGARY.

a) Austria.

8. — Austrian State Railway.
9. — Bukovina Local Railway.
10. — Austrian Southern Railway.

b) Hungary.

11. — Arad-Csanad Railway.

BELGIUM.

12. — National Suburban Railway Company.

EGYPT.

13. — Société Anonyme d'Entreprise Générale de Travaux « Fayoum Light Railways Company ».

UNITED STATES OF AMERICA.

14. — Baltimore & Ohio Railroad.
15. — Pennsylvania Lines West of Pittsburg

FRANCE.

16. — Orléans Railway.
17. — Paris-Lyon-Mediterranean Railway.
18. — St. Quentin-Guise and Aisne Department Railway.

GREAT BRITAIN.

Empire of India and Colonies.

19. — Eastern Bengal State Railway.
20. — North Western State Railway.
21. — Bombay, Baroda & Central India Railway.
22. — Natal Goverment Railways.

PORTUGAL.

23. — Portuguese National Railway Company.

RUSSIA.

24. — Moscow-Vindau-Rybinsk Railway.
25. — First Secondary Railway Company of Russia.

SWEDEN.

26. — Swedish State Railway.
27. — Stockholm-Rimbo Railway

SWITZERLAND

28. — Federal Railway.

2. — Summary of the answers relating to the first supplement subject XIX, littera A.

Is it advisable to protect the wheels and the moving parts by a metal cover ?

The administrations enumerated below use no such protective covers on the lines which fall within the scope of this report, and express no opinions as to their value :

8 (1). *Austrian State Railway.*

14. *Baltimore & Ohio Railroad.*

15. *Pennsylvania Lines West of Pittsburgh.* — The front end is protected by a so-called " pilot " or " cow-catcher ", which is essential in the case of trespassing men or animals being on the track. It is to be recommended.

17. *Paris-Lyons-Mediterranean Railway.*

19. *Eastern Bengal Railway.*

20. *North Western State Railway of India.* — This only runs on its own special track.

22. *Natal Government Railways.*

24. *Moscou-Vindau-Rybinsk Railway.*

25. *First Secondary Railway Company of Russia.*

26. *Swedish State Railway.* — 1·5 kilometres (0·93 mile) of street are also used by the railway.

27. *Stockholm-Rimbo Railway.*

28. *Swedish Federal Railway.* — On the Brunig line the street is not used.

(1) The numbers placed before the names of the administrations are the index numbers of the list given in appendix II.

a) *Length of streets, also used by the railway, in villages and towns. Length of highway, also used by the railway, outside villages and towns. Width of streets and highways.*

1. *Alsace-Lorraine State Railway.* — Two of the narrow-gauge lines have their own road-bed; the third, 22 kilometres (13·7 miles) long, is laid on streets; about 8·5 kilometres (5·28 miles) of it are inside villages and towns. The width of the streets varies between 8 and 10 metres (25 ft. 7 in. and 32 ft. 10 in.).

2. *Bavarian State Railway.* — The streets are also used, about 1·9 kilometres (1·2 miles) being inside continuous villages and towns, and 6 kilometres (3·7 miles) outside. The width of the streets varies between 4·9 and 20 metres (16 ft. 1 in. and 65 ft. 8 in.).

3. *Prussian-Hessian State Railway, Erfurt Directorate.* — The streets are also used, about 3·6 kilometres (2·2 miles) being inside continuous villages and towns, and 34 kilometres (21·1 miles) outside. The width of the streets varies between 9 and 15 metres (29 ft. 6 in. and 49 ft. 3 in.).

5 *Saxon State Railway.* — The streets are also used, 1·4 kilometres (0·87 mile) being inside continuous villages and towns, and 3 9 kilometres (2·4 miles) outside. The streets have a width of from 7·5 to 10 metres (24 ft. 7 in. to 32 ft. 10 in.).

6. *Wurtemberg State Railway.* — 0·675 kilometre (0·419 mile) of street inside continuous villages and towns, and 11·45 kilometres (7·11 miles) outside are used for the railway. These streets have a width of 5 metres (16 ft. 5 in).

9. *Bukovina Local Railway.* — All the nar-

row-gauge lines have special roads-beds of their own.

10. *Austrian Southern Railway.* — Streets inside continuous villages and towns are not used. Outside 1·35 kilometres (0 838 mile) of highway, 6 metres (19 ft. 8 in.) wide, are used by the Külmsdorf-Eisenkappel line, and 9·8 kilometres (6·1 miles) of highway, 9 metres (29 ft. 6 in.) wide, are used by the Mori-Arco-Riva line. All the other narrow-gauge lines have special road-beds of their own.

11. *Arad-Csanad Railway.* — 12 kilometres (7·5 miles) of street are used inside continuous villages and towns, and 75 kilometres (46·6 miles) outside; these have a width of from 10 to 20 metres (32 ft. 10 in. to 65 ft. 8 in.).

12. *Belgian National Suburban Railway Company.* — 1,704 kilometres (1,059 miles) are on unwidened streets and 318 kilometres (198 miles) are on widened streets.

16. *Orleans Railway.* — No streets are used inside continuous villages or towns. Outside them the Blois-St. Aignan line does not use the highway, nor does the Blanc Argent line; but 7·66 kilometres (4·76 miles) of the Coreze line are on highways having a width of 10 metres (32 ft. 10 in.), 6 metres (19 ft. 8 in.) of which are left clear for the ordinary wheeled traffic.

18. *St. Quentin-Guise and Aisne Department Railway.* — 2 kilometres (1·2 miles) of local line use the streets as well.

21. *Bombay, Baroda & Central India Railway.* — Streets and highways are not used.

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b) *Are such coverings used?*

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1. *Alsace-Lorraine Railway.* — Protective coverings are not used on our narrowgauge locomotives.

2. *Bavarian State Railway.* — Yes.

3. *Prussian Hessian State Railway* — No.

5. *Saxon State Railway.* — Yes, in the case of the Fairlie locomotive.

6. *Wurtemberg State Railway.* — Yes, in the case of the locomotives type T s 4, used on a gauge of 1 metre (3 ft. 3 3/8 in).

7. *Argentine Northern Railway.* — No.

9. *Bukovina Local Railway.* — None are used on the narrow-gauge locomotives. In the case of standard-gauge locomotives used for hauling on lines which also use streets, we have given up the use of such coverings.

10. *Austrian Southern Railway.* — On the Mori-Arco-Riva line such coverings were used when the line was opened to traffic in 1891; they were removed in 1896 and have not been used since. They were never in use on the other narrow-gauge lines.

11. *Arad-Csanad Railway.* — The whole mechanism is boxed in and runs in an oil-bath.

12. *Belgian National Suburban Railway Company.* — Yes.

13. *Fayoum Light Railways Company.* — Yes.

16. *Orleans Railway.* — On the St. Aignan-Blois line such coverings are used, but not on the other narrow-gauge lines.

18. *St. Quentin-Guise and Aisne Department Railway.* — In the local service no, in the tramway service yes.

21. *Bombay, Baroda & Central India Railway.* — The connecting and coupling roads and valve gear are cased in to protect them from dust. They are used on these engines but none are fitted to older types.

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c) *What observations have been made as to the use of such coverings generally : As regards*

the shying of draft animals; As regards accidents, collisions with other vehicles? How does this effect the operation and the maintenance of the engine?

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2. *Bavarian State Railway.* — In every respect favourable. The operation and the maintenance are simple.

5. *Saxon State Railway.* — No particular advantage has been observed. The shying of animals is not to be feared, if the mechanism is exposed, as the platform which extends beyond the mechanism hides it almost wholly from the animals. The platform also prevents damage in case any other vehicles approach too closely.

Protective coverings make it more difficult to attend to the mechanism.

6. *Wurtemberg State Railway.* — The protective covering has given goods results on lines which use the streets as well: in particular they protect the driving gear against the dust which is raised, and against the mud when it is bad weather, and prevent the accumulation of ice and snow in the mechanism in winter. As the reciprocating parts are hidden from view, animals are less apt to shy than if the protective coverings were absent.

The coverings reduce the effect of violent collisions; minor collisions become less dangerous as the protective covering prevents any contact with the moving parts.

The coverings give no particular trouble as regards the operation of the engine; as regards the maintenance of the latter, the coverings can easily and quickly be removed.

9. *Bukovina Local Railway.* — In the case of standard-gauge locomotives, used for traction on lines which also use streets, such coverings were at first used; but we gave them up because we found that animals shied as much at locomotives with coverings as at locomotives without.

10. *Austrian Southern Railway.* — On the Mori-Arco-Riva local line, when there was deed snow, a small amount of trouble arose as the coverings became undone because the doors projected slightly beyond the loading gauge. In order to prevent such an occurence, which might give rise to serious trouble, the coverings were removed.

On all the other narrow-gauge lines, the absence of coverings has never given rise to any accident or trouble.

Coverings make it more difficult to operate the engine, especially at roadside stations where the stops are short. The mechanism is not appreciably benefited by such coverings, unless they are dust-proof, as it is just the finely-powdered dust which penetrates the bearings of the mechanism and accelerates the wear.

12. *Belgian National Suburban Railway Company.* — When coverings are used, the mechanism wears much better, especially when the track is along dusty roads.

13. *Fayoum Light Railways Company.* — The coverings are efficacious with outside frame, as it is then possible to have them nearly dust-proof. The coverings must be at least 100 millimetres (4 inches) above rail-level. As a rule the points of collision are higher than the mechanism. The rubbing surfaces require less maintenance,

18. *St. Quentin-Guise and Aisne Department Railway.* — We are of opinion that their object is not so much for avoiding the scaring of animals, and accidents and collisions which are very rare, as for reducing the maintenance. But in order that this saving may be real, it is necessary that the protection should be complete, that is to say that the mechanism should be wholly enclosed. If it is not, partial protection is harmful rather than useful.

21. *Bombay, Baroda & Central India Railway.* — Oil is saved as no dust can reach the working parts. All parts are easily aceessible

and slide bars would give trouble from dust if not protected.

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d) *Does the use of such coverings seem necessary, and under what condition? Is it to be recommended? Or does it appear superfluous?*

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1. *Alsace-Lorraine Railway.* — We do not consider the use of coverings to be necessary.

2. *Bavarian State Railway.* — The use of such coverings seems necessary if the line runs for some distance alongside a street or highway or on it.

3. *Prussian-Hessian State Railway, Erfurt Directorate.* — No. The advantage would be counterbalanced by making the moving parts less accessible.

4. *Prussian-Hessian State Railway, Kattowitz Directorate.* — Coverings are not recommended, as they reduce the accessibility. There are no streets used where much dust could be produced.

5. *Saxon State Railway.* — It does not seem absolutely necessary to place protective coverings over the moving parts.

It is advisable to put a covering over the parts at the cylinders, in order to reduce the noise should a stuffing-box leak. Otherwise, coverings may be considered unnecessary under the existing conditions.

6. *Wurtemberg State Railway.* — Protective coverings are useful and to be recommended for lines on which there is danger of collision with vehicles and persons. The protective coverings should be properly designed so as to make it possible to take them down readily, so as to make it easy to operate the mechanism and make it accessible. It seems to us that such protective coverings are superfluous on lines wich have a road bed of their own.

7. *Argentine Northern Railway.* — The use of such metal coverings would be particularly advantageous in this case, owing to the great quantity of dust raised when running, as the track is not ballasted.

9. *Bukovina Local Railway.* — When the line passes over streets where there is much traffic, such coverings are to be recommended.

10. *Austrian Southern Railway.* — The use of such protective coverings does not seem to be necessary on our narrow-gauge lines.

12. *Belgian National Suburban Railway Company.* — Yes, particularly on lines running on streets or highways, or running alongside them.

13. *Fayoum Light Railways Company.* — We recommend the use of coverings, provided they are nearly air-tight, in the case of lines which run along dusty or sandy streets or highways.

The same statement is made as regards the Romagna steam tramway system.

16. *Orleans Railway.* — Coverings are recommended for those locomotives which have to run on dusty roads.

21. *Bombay, Baroda & Central India Railway.* — It entirely depends on the ballast. They are required on our road as there is so much sand and dust.

23. *Portuguese National Railway Company.* — We do not think it advisable to cover the wheels or the moving parts of the mechanism.

APPENDIX III.

3. — List of the administrations who sent answers to the list of questions relating to the second supplement of subject XIX, littera A.

GERMANY.

1. — Alsace-Lorraine Railway.
2. — Bavarian State Railway.
3. — Prussian-Hessian State Railway, Erfurt Directorate.
4. — Prussian-Hessian State Railway, Kattowitz Directorate.
5. — Saxon State Railway.
6. — Wurtemberg State Railway.

AUSTRIA AND HUNGARY.

a) Austria.

7. — Austrian State Railway.
8. — Bukovina Local Railway.

b) Hungary.

9. — Arad-Csanad Railway.
10. — Kaschau-Oderberg Railway.

BELGIUM.

11. — Belgian National Suburban Railway Company.

EGYPT.

12. — Société anonyme d'entreprise générale de travaux (Belgium). «Fayoum Light Railways Company. »

UNITED STATES OF AMERICA.

13. — Baltimore & Ohio Railroad.

FRANCE.

14. — Orleans Railway.
15. — Paris-Lyons-Mediterranean Railway.
16. — St. Quentin-Guise and Aisne Department Railway.

GREAT BRITAIN.

a) United Kingdom.

17. — Great Western Railway.

b) Empire of India and Colonies.

18. — Bombay, Baroda & Central India Railway.
19. — Central South Africa Government Railways.
20. — Natal Government Railways.

RUSSIA.

21. — Moscow-Vindau-Rybinsk Railway.
22. — First Secondary Railway Company of Russia.

SWEDEN.

23. — Swedish State Railway.

SWITZERLAND.

24. — Swiss Federal Railway.

Summary of the answers relating to the first supplement.

Is it advisable to have a footplate at each end of the locomotive? What regulations are there on the subject?

The following administrations have stated that no locomotives are used on the lines falling within the scope of this report, which have two footplates, and have expressed no opinion as to the utility or need of such an arrangement.

4 (1). *Prussian-Hessian State Railway, Kattowitz Directorate.*

5. *Saxon State Railway.* — This has platforms extending round the locomotives of the Fairlie type, but not with the object of driving the locomotive from the head of the train, as the cab is in the middle of the locomotive.

6. *Wurtemberg State Railway.*

7. *Austrian State Railway.*

10. *Kaschau-Oderberg Railway.*

13. *Baltimore & Ohio Railroad.*

15. *Paris-Lyons-Mediterranean Railway.*

18. *Bombay, Baroda & Central India Railway.*

19. *Central South Africa Government Railways.*

20. *Natal Government Railways.*

21. *Moscow-Vindau-Rybinsk Railway.*

22. *First Secondary Railway Company of Russia.* — There is no experience available.

23. *Swedish State Railway.*

The following administrations do not use locomotives with two footplates and do not consider them necessary.

1. *Alsace-Lorraine Railway.* — All of our narrow-gauge locomotives are tank locomotives with one footplate only. We consider a second footplate superfluous. The communication cord makes communication between the locomotive and the train possible.

3. *Prussian-Hessian State Railway, Erfurt Directorate.* — No need for this has ever become apparent in this district.

8. *Bukovina Local Railway.* — There is no second footplate and its absence gives rise to no inconvenience.

12. *Société anonyme d'entreprise générale de travaux. Fayoum Light Railways Company* and *Romagna steam tramway.* — The advantages are problematic; the staff is not in favour of it and fears accidents, and does not want to use them.

14. *Orleans Railway.* — Two footplates are useless in the case of our undertaking.

24. *Swiss Federal Railway.* — There are no second footplates and such are not used.

a) Diagram showing the arrangement of the handles used in driving the locomotives.

b) Can the locomotives be driven from either footplate?

c) Is it necessary to do stoking while running?

2. *Bavarian State Railway.* — *a)* The locomotives are tank locomotives; the footplate is

(1) The numbers placed before the names of the administrations are the index numbers of the list given in appendix III.

at one end and there is a small platform at the other. — *b*) No, only from the footplate. — *c*) Yes.

9. *Arad-Csanad Railway.* — The tractors have the footplate in the middle, affording a clear view in either direction.

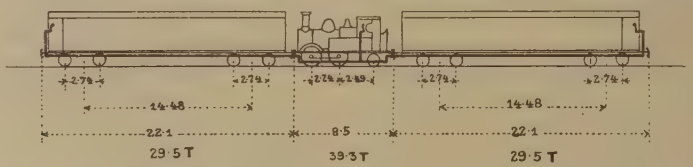
11. *Belgian National Suburban Railway Company.* — There is a footplate at each end of the locomotive, and the locomotive can be driven from either footplate. It is necessary to do stoking while running.

16. *St. Quentin and Aisne Department Railway.* — *b*) This railway has locomotives with a footplate at each end. The shaft by means of which the regulator is operated passes through the whole length of the boiler and has at each end a lever and handle, so that the regulator can be operated from either footplate. A lever is also placed on each footplate for working the reversing gear. These two levers are connected by a rod, which operates the valve gear, so that the cut-off may be set as desired from either footplate.

c) It is necessary to do stoking while running.

17. *Great Western Railway* (*Great Britain*). — Standard gauge.

a) The train consists of two cars, with a locomotive placed between them. The two cars have a driver's compartment at each end of the train, as shown in the adjoining sketch



b) The regulator of the locomotive can be operated from the footplate and from the driver's compartment in either car, by means of shafts which extend below the floor of the cars and under the locomotive, and are connected by flexible couplings.

c) It is necessary to do stoking while running.

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d) What auxiliary means are provided to enable the employees on the two footplates to communicate with each other in those cases in which the locomotive can not be driven from either footplate?

What auxiliary means are available, in the case of locomotives running backwards, to enable the watchmen in charge of a given section of line to make a locomotive stop?

Is there any communication between the two footplates, and between these and the train, which can be used while the train is running?

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2. *Bavarian State Railway.* — The footplate is connected with the front platform by a run-board with railing, which can also be used while the train is running. Hinged gangway footplates at the ends of the carriages give access to the train.

9. *Arad-Csanad Railway.* — There is no communication with the train.

11. *Belgian National Suburban Railway Company.* — The driver and the fireman see each other. There is no communication between locomotive and train.

16. *St. Quentin-Guise and Aisne Department Railway.* — The footplate of the locomotive and the platform of the carriage are next to each other.

17. *Great Western Railway* (*Great Britain*). — Communication between the train and the locomotive staff is effected by means of the prescribed steam-whistle signals and electric-bell signals.

e) *What advantages does this have: 1° As regards the safety of the working? 2° Does this arrangement make it possible to reduce the number of employees on the train, as compared with former arrangements? 3° Does this result in a reduction in the working expenses? 4° Does this result in a saving of capital expenditure, as compared with the use of turntables?*

f) *Is this arrangement recommended?*

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2. *Bavarian State Railway.* — *e*) 1° The possibility of passing from the locomotive to the train and vice versa while running. — *e*) 2° Yes, because one man only is required for the locomotive. — *e*) 3° Yes. — *e*) 4° Turntables do not enter into consideration as tank locomotives are used. — *f*) Yes.

11. *Belgian National Suburban Railway Company.* — *e*) 1° The driver can see the track in front of him much better and this gives greater security. — *e*) 2° No. — *e*) 3° No. — *e*) 4° Yes. — *f*) Yes.

12. *Société anonyme d'entreprise générale de travaux.* — The use of two footplates is not recommended.

16. *St. Quentin-Guise and Aisne Department Railway.* — The staff can not be reduced. The capital outlay is less than for turntables. The use of two footplates is recommended.

17. *Great Western Railway* (*Great Britain*). — No reduction in the number of employees on the train results. The fireman is always on the footplate of the locomotive, while the driver is in the driver's compartment at the head of the train.

SECTIONAL DISCUSSION

Meeting held 6 July 1910 (morning).

MR. VON ZIFFER, VICE-PRESIDENT IN THE CHAIR

The President. (In French.) — We now begin the discussion of question XIX.

I call upon Mr. Jesser to give a summary of his report.

Mr. Jesser, *reporter.* (In German.) — The programme of the 5th section of the present session of the Congress includes, among other questions, that of the present system of construction of locomotives and rolling stock, and I have the honour to submit to you a report on this question, which is of extreme importance to the development of narrow-gauge railways.

In accordance with the usual practice, the administrations belonging to the Congress were requested, by the kind intermediacy of our general secretary, Mr. Weissenbruch, to place at my disposal the information about the types which have given good results, which was necessary in order to form an opinion of the present state of the question, and many railways have very kindly supplied me with detailed information about their practice.

I beg to refer you, in connection with this point as well as with all others which it would take us too long to examine here, to my report, together with its appendices, which you have received.

The many answers which I have received in answer to my list of questions lead us to conclude that the engineers specially dealing with this service show great interest in this subject, and as it is above all thanks to this participation that our deliberations can lead to a satisfactory result, I think that I express the feeling of the section by giving our collaborators our best thanks for the valuable assistance they have given to our common cause.

In a certain sense I may even venture to assert that the material supplied was too ample, for a preliminary examination showed that the proper study of modern rolling stock, its comparison with older types and the simultaneous consideration of the progress made, would be too voluminous a piece of work to be condensed into a single report. Accordingly I found myself compelled to limit myself to littera *A*, locomotives, or else I should have been unable to consider the subject from all desirable points of view, and I therefore propose to the section that the investigation of littera *B* of the question, relating

to the carriages and wagons, should be postponed to a future session of the Congress.

To pass now to the question we are going to consider today, I begin by mentioning in a general way that the information supplied by forty administrations relates to lines of nine gauges differing materially from each other, varying from 0·610 to 1·067 metres (2 feet to 3 ft. 6 in.), with nearly 1,400 locomotives of 107 different types.

Excluding for the moment one great undertaking which has more than 560 locomotives, and taking only the remaining railways, there are on the average only about eight locomotives per type, and this proportion is much more unfavourable in the case of many small undertakings.

It is beyond doubt that this promotes high prime cost and cost of working, which could be reduced by standardizing types and dimensions, and that this disadvantage is to a large extent due to the adoption of so many different gauges.

Let us now consider the locomotives of different gauges. The qualities which are of special interest to us in these locomotives, are the ability to run round curves as easily as possible, at a sufficient speed, at the expenditure of a tractive effort or power proportioned to the needs of the traffic, without exceeding the maximum axle-loads which a comparatively light track and roadbed can carry. From this point of view, exceptionally severe conditions are imposed above all on the types of locomotives used on narrow-gauge lines, for the necessity of reducing as much as possible the cost of construction of such lines leads in many cases to the adoption of sharp curves and of steep gradients.

Now, although in making a comparative study of the different types, the tractive efforts which can be developed under different conditions of profile can easily be deduced from the adhesive weight and the total weight, yet matters are altogether different as regards the power which assuming all the chief dimensions to be properly proportioned to each other, is subordinated to a certain number of factors. Such are the heating surface, its division between fire-box and smoke tubes, the working pressure, the temperature of the steam, the simple or double expansion of the steam, finally, all the factors affecting the heating, such as the nature and the properties of the fuel, the strength of the draft and the skill of the locomotive crews. Even excluding the latter factors, which have preponderating influence on the power obtainable and can hardly be determined numerically, the first set of factors is already not easy to elucidate sufficiently to obtain an exact idea of the subject. It hence appeared necessary to make, by way of comparison, a uniform determination of the powers.

As the ordinary data relating to the evaporative power and the consumption of steam apply usually to locomotives with large fire-boxes, they cannot be utilized as they stand for the conditions which we are considering, and the determination of the power is based on experimental coefficients determined during a series of trial runs made with locomotives on narrow-gauge lines. According to the results obtained, the working pressure in atmospheres multiplied by the fire-box heating surface plus quarter the smoke-tube heat-

ing surface, repesents, with sufficient approximation, the available output in horse-power, when Cardiff coal is used and the draft is brisk. In cases of superheating and compounding, this figure for the power can in each case be increased by over 10 per cent.

If we analyse the information supplied about the different types of locomotives, taking as basis the considerations just brought forward, we find that the following measures have been used with success to increase the power of the new as compared with the older types :

1° Increasing the working pressure of the boilers;

2° Superheating the steam;

3° Compounding.

The *working pressure* varies, in the case of ordinary locomotive boilers, between 8 and 14 atmospheres; in the great majority it amounts to 12 atmospheres and is most frequently fixed at this figure which may now be considered as standard. Pressures of between 12 and 13 atmospheres have been in use on fifteen types since 1896, and pressures of between 13 and 14 atmospheres have been in use on four types, since 1901, on German, French and Italian railways. This excellent method of increasing the power, which involves a comparatively slight increase in the weight of the locomotives, could be used all the more readily in the case of narrow-gauge railways, as the increase in the temperature of the walls of the boiler, an increase corresponding with the pressure, exercises, owing to the relative shortness of the fire-boxes, a less injurious influence on the stays than in the case of large fire-boxes, and further progress in this direction is to be expected.

Superheating the steam has been introduced since 1901 on six types, and now goes up to 300° C. (572° Fahr.). It is adopted above all in countries where fuel is scarce, and it may be concluded that the better utilization of the latter has contributed towards the selection of this system.

Compounding has been used on a large scale since 1892; according to the information received, it is applied on fourteen types of engines. Five of these, having two independent motor trucks, are equipped with four cylinders, while the others, where space is more limited, only have two. Compounding everywhere followed the introduction of medium pressures and above all that of high pressures, exceeding 12 atmospheres.

Among the locomotives designed for similar axle-load limits and lines of similar kind, the most powerful are those which have one or more of the improvements just described. The following may be mentioned :

Lines with a gauge of 610 millimetres (2 feet) : 4-6-2 tank locomotive of the Natal Government Railways, giving 215 horse-power, or 8·13 per ton of weight of the locomotive, the working pressure being 11·6 atmospheres.

Lines with a gauge of 750 millimetres (2 ft. 5 1/2 in.) : 0-8-0 tank locomotive of the Saxon State Railway, giving 250 horse-power, or 8·7 per ton of weight of the locomotive, with two cylinders, compound working and a pressure of 14 atmospheres.

Lines with a gauge of 760 millimetres (2 ft. 5 15/16 in.) : 0-6-4 tank locomotive of the Austrian State Railway, giving 280 horse-power, the highest power rela-

tively to the weight of the locomotive, namely 10·57 horse-power per ton of gross weight. This is a compound, with a working pressure of 13 atmospheres.

Lines with a gauge of 890 millimetres (2 ft. 11 3/64 in.) : 2-6-2 tank locomotive of the Swedish State Railway, giving 280 horse-power, or 8·37 per ton of weight of the locomotive. The boiler works at a pressure of 11 atmospheres and has a superheater.

Lines with a gauge of 950 millimetres (3 ft. 1 3/8 in.) : 0-8-0 tank locomotive of the Italian State Railway, giving 430 horse-power, or 8·98 per ton of weight of the locomotive. The working pressure is 14 atmospheres.

Lines with a gauge of 1 metre (3 ft. 3 3/8 in.) : 0-4 + 4-0 tank locomotive of the Saxon State Railway, giving 395 horse-power, or 9·43 per ton of weight of the locomotive; compound, 14 atmospheres. Also 0-4 + 4-0 tank locomotive of the Orleans Railway, giving 370 horse-power, or 9·25 per ton of weight of the locomotive; compound, 14 atmospheres.

Appreciably higher powers have been obtained by locomotives with separate tender and by the use of heavier axle-loads, in the case of lines where conditions are favourable. In this connection I may mention, for purposes of comparison, the following :

Lines with a gauge of 762 millimetres (2 ft. 6 in.) : 2-8-2 locomotive, with separate tender, of the Bengal-Nagpur Railway (Empire of India), giving 410 horse-power, or 6·95 per ton of gross weight; working pressure, 12 atmospheres.

Lines with a gauge of 914 millimetres (3 feet) : 2-8-0 locomotive, with separate tender, of the Chicago, Burlington, and Quincy Railway, giving 500 horse-power, working pressure 12 7 atmospheres. This great power is due to the heavy axle-load, 12 tons. An interesting feature of this type is that although it has a rigid wheel-base of 3·023 metres (9 ft. 11 in.), for the four coupled axles, yet it can run round curves having a radius of 47 metres (2·35 chains), without any special device except giving the axles a slight lateral play in their bearings. An increase in the wear of the tires and rails has been preferred to the use of complicated gear for giving the coupled wheels radial adjustment.

Lines with a gauge of 1 metre (3 ft. 3 3/8 in.) : 4-6-0 locomotive, with separate tender, of the Argentine Northern Railway, giving 460 horse-power, or 6·23 per ton of gross weight, with a working pressure of 12 atmospheres. Finally, there is the 2-8-0 locomotive with separate tender, of the Rhetian Railway, the most powerful of all the types, giving 520 horse-power, with a working pressure of 12 atmospheres, and using superheated steam.

We now pass to the second principal property, the tractive effort. We may mention, as of particular interest, the types making it possible to increase the *adhesive weight* beyond the limits feasible when rigid wheelbases are used.

Apart from allowing suitable play in the axle-boxes and having no flanges on some of the coupled wheels, the devices adopted for this purpose can be classified into two chief groups :

1° Having individual pairs of wheels with radial adjustment;

2° Having sets of driving wheels the axles of which are mounted in separate frames.

In those two cases, the driving is effected either purely by mechanical transmission of the action of a pair of chief steam engines, or by a special and complete pair of steam motors for each bogie. Altogether thirteen of these designs exist, in which the object aimed at is attained more or less completely, sometimes, it is true, at the price of great complication; thus there are eight types with radial pairs of wheels and five types with bogies with independent motors.

The first group includes a tractor with two free flexible axles each of which is driven, by a two cylinder de Dion-Bouton engine, with toothed-gear transmission; also seven types of 0-8-0 tank locomotives, two of which have a single free flexible axle and five have two flexible axles. One of the latter is on the Klose system, with mechanical device to provide for the change of length of the coupling rod; all the others are on the Klien-Lindner system, in which the power of the engine is transmitted to a rigid coupled shaft and its torque to pairs of radial wheels mounted by means of a hollow axle concentric with the shaft.

These devices make it possible to obtain, when the axle-loads are 6 to 7·6 tons, an adhesive weight of from 24 to nearly 30 tons, and although the total wheelbases are 3·900 to 4·050 metres (12 ft. 9 $^{9}/_{16}$ in. to 13 ft. 3 $^{1}/_{2}$ in.), to run round curves having a radius of as little as 40 metres (2 chains) on the open line and of 35 metres (1 $^{3}/_{4}$ chains) at switches.

Among the designs with *two motor bogies*, I must mention a type on the Hagans system, used on the Prussian-Hessian State Railway, on lines having a gauge of 785 millimetres (2 ft. 6 $^{29}/_{32}$ in.). The power developed by a single-expansion engine which is fixed to the main frame drives three pairs of rigid wheels and also two axles of a bogie, to which it is transmitted by means of articulated levers.

With the very moderate axle-load of 5·5 tons, it was possible to obtain an adhesive weight of over 27 tons, and although the total driving-wheel base is 4·650 metres (15 ft. 3 in.), it is possible to run round curves having a radius of 35 or 40 metres (1 $^{3}/_{4}$ or 2 chains).

But by far the easiest method of adapting long wheelbases to unfavourable curves is the use of two driving bogies, each actuated by a complete and independent pair of steam engines.

This design is represented by two different types. The older has two driving bogies, movable relatively to the main frame plates, while the more recent has one driving bogie in the main frame and another which is movable. The Saxon State Railway has some of the former type, on the Meyer system, in use on lines with a gauge of 750 millimetres (2 ft. 5 $^{1}/_{2}$ in.), and some of the latter type, on the Fairlie system, with its characteristic double boiler, on 1 metre (3 ft. 3 $^{3}/_{8}$ in.) gauge lines.

Quite recently the firm of Beyer, Peacock & Co., Limited, of Manchester, has again tried this system as improved by Mr. Garratt, and by placing the two driving bogies at the ends of the main frame plates in front and behind the boiler of the locomotives, it has obtained sundry advantages from the point of view of free development of the different details. Locomotives of this kind have recently been built for the Tasmanian Government Railway.

The Mallet-Rimrott system, with a movable driving bogie, has been applied

to a type built for the Wurtemberg State Railway and to one intended for the Orleans Railway.

To sum up, assuming the maximum axle-loads to be equal, it is not possible to obtain, with these locomotives of the 0-4 + 4-0 type, a greater adhesive weight than with the 0-8-0 type with flexible coupled axles. On the other hand, it is possible to have a much longer wheelbase, so that the weight is distributed more advantageously. Consequently, this design makes it possible to increase the adhesive weight, with a suitably-strengthened track, without extra fatigue of the substructure.

At present, axle-loads of 5·49 to 10·6 tons are used, giving an adhesive weight of 27·15 to 41·8 tons. The wheelbases vary between 4·400 and 7·600 metres (between 14 ft. 5 in. and 25 feet), and the ease of negociating curves is such that with the longest wheelbases it is possible to run round curves having a radius of 30 or 25 metres (1 $^1/_2$ or 1 $^1/_4$ chains).

We have now examined in detail the chief different types of locomotives.

We may assert with satisfaction not only that locomotive builders have always been able to meet the most severe demands made when new lines were schemed, but also that during the few tens of years that such lines have been operated, quality coefficients have been obtained which in many cases are twice, or even more, as good as at first.

Now, however satisfactory these considerations may be, we must not dwell any further on them, for the question of the latest locomotive types could not have as its sole object the collection of data, although these are of considerable value for determining the capacity of such lines; but what formed its real object were the conclusions, to be drawn from the large total of the brain work which has been devoted in each individual case to the design of the different types, in the manufacturing countries of the whole world.

If in the first place we examine the influence exercised by the plan and profile of the line and the strength of the track on the development of the locomotives, in order to ascertain how to obtain the most favourable combination of track and of operation, we come to the logical conclusion that in the case of new lines the track should be designed to suit those properties of the locomotives, which can be at present obtained with good designs, and which are required not only for the traffic immediately to be expected, but also for a traffic which has increased to a corresponding extent.

Starting from this point of view, we shall in what follows enumerate, and give reasons for, those proposals which we should as a rule recommend, when it is a question of building new narrow-gauge lines for public traffic, to be operated by means of steam locomotives.

In the second place, we have to consider the measures which are advisable when acquiring new locomotives for existing lines, so as to obtain the power necessary for coping with the growing traffic, if the existing older types no longer suffice for this purpose.

Although these two points are not expressly laid down in the original wording of the question which is to be discussed, yet they necessarily follow from the examination of the subject, and indeed, what other body or corporation could be more able and more justified to

recommend the adoption of certain principles, recognized as advantageous, than the Congress of the administrations which operate the existing lines and not only have acquired wide experience on the subject, but also have suffered from the consequences of difficulties in operation, which have in many cases resulted from small economies at the time of construction which were quite out of proportion to the increase in the working expenses which resulted.

In the case of the separate points which are to be considered, we give in each case the position taken by the German *Verein* as laid down in *Grundzüge für den Bau und die Betriebseinrichtungen der Lokalbahnen.*

These principles are not, as they stand, suitable for at discussion the Railway Congress, because the ground covered is much wider, and because it is by no means the case that all principles which may give excellent results in individual cases, can also be applied generally, particularly if the necessary preliminary conditions are not the same; they are, however, of such importance from the point of view of narrow-gauge railways, that, on the one hand, they could not be omitted without leaving lacunæ, and, on the other, they give many important points useful in the solution of the question generally.

The subject itself may be subdivided as follows :

A) *Track :*

1° Gauge; 2° gradients; 3° curves; 4° wheel-loads.

B) *Locomotives :*

1° Increase of power; 2° increase of adhesive weight.

A. — *Conclusions as regards track.*

1° The evolution of such a large number of different *gauges,* as described above, which in many cases only show very small differences, cannot be looked upon as an absolute necessity for the proper designing of the lines; and taking into consideration the resulting increase in the number of locomotive types and their consequent greater cost of construction and of maintenance, the selection of any other gauge than those already in existence must be looked upon as disadvantageous to the development of the narrow-gauge railway industry.

Taking into consideration that it has been possible to construct metre (3 ft. 3 3/8 in.) gauge locomotives which can run round as sharp curves as locomotives of smaller gauge, curves with a radius of as little as 30 metres (1 1/2 chains) and in one case even of 21 metres (1·05 chains), and also taking into consideration that it is possible to design, for this gauge, locomotives of considerable power, more capable of operating a growing traffic than would be the case with a narrower gauge, I think that the metre (3 ft. 3 3/8 in.) gauge is particularly advantageous in the cases where the new lines to be built are not directly connected with narrow-gauge lines of different gauge.

The German *Verein* has laid down the following conclusions in *Grundzügen*, paragraph 2, section 2 :

The gauge of 1,000 millimetres or of 750 millimetres (3 ft. 3 3/8 in. or 2 ft. 5 1/2 in.), is recommended for narrow-gauge local lines. In the case of minor railways, a gauge of 600 millimetres (1 ft. 11 5/8 in.) is still admissible. If a narrow-gauge system of larger

extent, having another gauge, already exists, it is advisable also to select this gauge for any new lines added to it.

Such a definite wording of this principle could hardly be adopted by the Congress, if only on account of the different systems of weights and measures, the general recommendation of a gauge of 1 metre (3 ft. 3 3/8 in.), without excluding other gauges which already exist, would better suit the objects which we are here considering; and it might be added that for lines which are to carry public traffic, the gauge of 600 millimetres (1 ft. 11 5/8 in.) is the narrowest that can be recommended.

2° The gradients used on the different lines show much variety and it may here be mentioned that longish gradients of 25 to 30 per mil are reported by nine administrations, of up to 35 per mil by six, of up to 40 per mil by three and of up to 45 per mil by three administrations, while gradients of 58·8, 70 and 82·5 per mil were each reported by one administration, and we may assume that the latter is the limit of what is ordinarily practicable in this way.

The development of the locomotive is not so much hampered by the presence of steep gradients, as it is by the other difficulties presented by the track. On the other hand, for a given horse-power, the gross ton-mileage is materially reduced by the reduction of the train weight including the load on the carrying wheels of the locomotive and of the tender, if any, proportionately to the adhesive weight of the locomotive.

This circumstance makes it evident that it is uneconomic to have excessive gradients on lines where the trains are hauled by steam locomotives, and this the more so, the smaller the ratio of the length of the steep gradients to the total length of the line.

Grundzüge prescribes in this respect in paragraph 21, section 1 :

> The gradient on adhesion railways shall as a rule not exceed 40 per mil (1 : 25).

The main statement quoted can be recommended in its general form, as it expresses that it is desirable not to have gradients steeper than 40 per mil; the qualification " as a rule " allows the engineer planning the line to select steeper gradients in special cases after careful consideration of all the circumstances, for and against, particularly of the higher initial outlay or cost of working.

3° The curves also show very great differences; we find everything from a very large minimum radius down to a radius of 21 metres (1·05 chains).

The dimensions have a very great effect both on the service and on the design of the locomotives.

In the first place, they affect the admissible speed, and we will here only note that the maximum reported speeds of over 50 and up to 65 kilometres (over 31 and up to 40·4 miles) per hour are as a rule limited to lines having curves with a minimum radius of 180 metres (9 chains), while one administration reports a minimum radius of 70 metres (3 1/2 chains) and a maximum admissible speed of 64·4 kilometres (40·0 miles) per hour.

On sharp curves, the maximum speeds for which the locomotives are designed are consequently reduced; they amount,

on the average, to about 40 kilometres (24·8 miles) per hour with radii of 60 metres (3 chains) and to 30 kilometres (18·6 miles) per hour with radii of 40 metres (2 chains).

Grundzüge prescribes in this respect in paragraph 22, section 1, clause *c* :

The radius of curves on narrow-gauge lines shall as a rule not be less than :

50 metres (2 1/2 chains) on lines with a gauge of 1,000 millimetres (3 ft. 3 3/8 in.);

40 metres (2 chains) on lines with a gauge of 750 millimetres (2 ft. 5 1/2 in.);

25 metres (1 1/4 chains) on lines with a gauge of 600 millimetres (1 ft. 11 5/8 in.).

Smaller radii can be used on all these lines, if the rolling stock is specially designed for running round sharp curves.

Then prescriptions follow as to the transition curves and the length of straights between reverse curves, which are to be at least 10 metres (32 ft. 10 in.) in length between the two superelevation gradients.

If the three dimensions here considered : gauge, rigid wheelbase and radius of curve, are directly proportionate to each other, the axles of the vehicles in all cases form the same angles with the radii of the curve.

But as the length of the locomotives and consequently of the most advantageous wheelbase does not decrease proportionately to the gauge, the need arises not to establish a direct proportion between the gauge and the radii of the curves, but to have a greater ratio between these two dimensions in the case of narrower gauges than in that of wider gauges.

Taking this circumstance into consideration, and also the existing lines, it seems advisable to place the matter on a simpler basis and to recommend the general adoption of the radius of 40 metres (2 chains) as a minimum, and to make any further reduction in this dimension dependent on the use of rolling stock which is so equipped that the axles have the required adjustability on the curves.

The straights between reverse curves should be at least as long as the greatest distance between bogie centres of any vehicle, if no guard rails are laid at these curves.

4° The admissible axle-loads and the admissible loads per metre of track are, among all the conditions mentioned, the most important factors in the designing of powerful locomotives, particularly in the case of lines with steep gradients

When we considered the different types of locomotives, we drew particular attention to the fact that some of the most powerful locomotives, giving the greatest tractive efforts, were designed for lines with very unfavourable curves, as it was possible to have great axle-loads.

Grundzüge prescribes, under construction and maintenance of rolling stock, in paragraph 41, section 2 :

The following maximum wheel-loads, measured in a state of rest, are recommended for the following gauges :

GAUGE.	WHEEL-LOAD.
1 metre (3 ft. 3 3/8 in.).	4·5 tons (4·4 English tons).
750 millimetres (2 ft. 5 1/2 in.).	4 tons (3·9 English tons).
600 millimetres (1 ft. 11 5/8 in.).	3·5 tons (3·4 English tons).

It is true that in practice these maximum wheel-loads recommended are not always attained; on the other hand, they are often materially exceeded.

It does not seem advisable to include such "maximum wheel-loads recommended" in our conclusions, as they would tend to limit the development of the power of the locomotives even more than many of the other difficulties of narrow-gauge lines, such as the curves and gradients, and therefore we propose the following wording : "An axle-load of 10 tons (9·8 English tons) is recommended for lines having a gauge of 1 metre (3 ft. 3 3/8 in. ; it is advisable, particularly on lines with steep gradients and on lines with sharp curves, to have as heavy axle-loads as possible."

B. — *Conclusions as regards locomotives.*

1° Taking into consideration the detailed investigation I have made of this subject, I recommend, in order to obtain locomotives of the *power* suited to the requirements of the traffic :

a) Increasing the working pressure to 14 atmospheres;

b) Superheating the steam to 300° C. (572° Fahr.);

c) Compounding.

One or more of these measures can be applied simultaneously, according to the circumstances of each case.

2° *The increase of the adhesive weight* beyond the figure which is determined by the maximum wheelbases for given minimum radii, by the admissible axle-loads and the maximum admissible loads per metre of track, is in the case of lines with steep gradients just as important a question as the increase of power.

Grundzüge recommends in paragraph 50 and 78 :

Locomotives and rolling stock which are to be used on lines where the under-mentioned curves frequently occur on the open line, should have rigid wheelbases not exceeding :

CURVES HAVING A RADIUS.	RIGID WHEELBASE	
	OF LOCOMOTIVE.	OF CARRIAGES.
25 metres (1 1/4 chains).	1·1 metres (3 ft. 7 5/16 in.).	1·4 metres (4 ft. 7 1/8 in.).
40 metres (2 chains).	1·5 metres (4 ft. 11 in.).	1·8 metres (5 ft. 10 7/8 in.).
50 metres (2 1/2 chains).	1·6 metres (5 ft. 3 in.).	2·0 metres (6 ft. 6 3/4 in.).
75 metres (3 3/4 chains).	2·0 metres (6 ft. 6 3/4 in.).	2·5 metres (8 ft. 2 7/16 in.).
100 metres (5 chains).	2·3 metres (7 ft. 6 9/16 in.).	2·9 metres (9 ft. 6 3/16 in.).
125 metres (6 1/4 chains).	2·6 metres (8 ft. 6 3/8 in.).	3·3 metres (10 ft. 10 in.).
150 metres (7 1/2 chains).	2·9 metres (9 ft. 6 3/16 in.).	3·6 metres (11 ft. 9 3/4 in.).
180 metres (9 chains).	3·2 metres (10 ft. 6 in.).	3·9 metres (12 ft. 9 9/16 in.).
210 metres (10 1/2 chains).	3·5 metres (11 ft. 5 13/16 in.).	4·3 metres (14 ft. 1 5/16 in.).

As regards the first, paragraph 51 states :

As regards locomotives with wheelbases exceeding the limits specified in paragraph 50, it is recommended to use bogies or radially-adjustable axles.

As far as can be gathered from the information received in answer to our list

of questions, the maximum wheelbases recommended by the German *Verein* for locomotives have been exceeded in a rather considerable number of cases; on the other hand, the wheelbases specified were not usually exceeded without having at least one or two of the coupled axles radially adjustable, or having one or two pairs of the coupled wheels made without flanges.

Accordingly, when the wheelbase dimensions given above are exceeded, it is in the first place advisable to use adjustable coupled axles, and if this does not suffice, the use of special motor bogies is then to be recommended.

I think I have now given a summary of all the points I consider of importance as regards the general features of the locomotives.

The President. (In French.) — Then kindly read out your conclusions.

Mr. Jesser. (In German.) — In giving a summary of my conclusions, I have intercalated explanations in the text of my conclusions, without reading them out on end. The conclusions which I recommend for adoption are given at the end of my report. I will now read them out, at the request of the President.

Locomotives suited to the character of the line and of the traffic on narrow-gauge railways.

A. — *The design of new narrow-gauge lines which are to be operated with steam locomotives, are to be used for public traffic, and have to deal with a considerable amount of passenger or goods traffic.*

1° In all the cases in which the selection of the gauge of a new line is not decided in advance by its immediate junction with another line or by some other administrative connection with an existing narrow-gauge system, a gauge of 1 metre (3 ft. 3 3/8 in.) is considered the best. A smaller gauge than 600 millimetres (1 ft. 11 5/8 in.), and the selection of a new gauge which does not yet exist, are not to be recommended;

2° In the case of adhesion lines, whose locomotives work without any artificial increase of friction, it appears as a rule advisable not to have steeper gradients than 40 per mil;

3° It is recommended as a rule not to have curves with a radius of less than 40 metres (2 chains), if the vehicles are not specially designed for sharper curves. It is desirable to have the straights between the super-elevation gradients of reverse curves, which are not equipped with guard rails, not shorter than the greatest existing distance between the bogies of a vehicle;

4° If a busy traffic has to be dealt with, it appears advisable to build the road and road-bed of a line having a gauge of 1 metre (3 ft. 3 3/8 in.), of such a strength that it can stand an axle-load of 10 tons (9·84 English tons); it is recommended, particularly in the case of lines with steep gradients and sharp curves, to provide for greater axle-loads.

B. — *As regards the design of new locomotives.*

1° The following may be recommended *in order to increase the power of locomotives:*

a) The use of a *working pressure* of up to 14 atmospheres;

b) *Superheating the steam* to 300° C. (572° Fahr.);

c) *Compounding.*

2° On lines on which the following curves frequently occur on the open line, no greater

rigid wheelbases should be used than those given in the following table :

RADIUS OF CURVE.	RIGID WHEELBASE.
25 metres (1 1/4 chains).	1·4 metres (4 ft. 7 1/8 in.).
40 metres (2 chains).	1·8 metres (5 ft. 10 7/8 in.).
50 metres (2 1/2 chains).	2·0 metres (6 ft. 6 3/4 in.).
75 metres (3 3/4 chains).	2·5 metres (8 ft. 2 7/16 in.).
100 metres (5 chains).	2·9 metres (9 ft. 6 3/16 in.).
125 metres (6 1/4 chains).	3·3 metres (10 ft. 10 in.).
150 metres (7 1/2 chains).	3·6 metres (11 ft. 9 3/4 in.).
180 metres (9 chains).	3·9 metres (12 ft. 9 9/16 in.).

If the adhesive weight necessary cannot be obtained inside the limits set by these wheelbases and the admissible maximum axle-loads, then, according to the excess required, the following arrangements can be recommended :

a) *Lateral play ;*

b) *Not having flanges* on some of the pairs of coupled wheels ; if these measures do not suffice, then ;

c) *Having some of the coupled axles radially adjustable* ; and finally,

d) *The use of one or two motor bogies movable relatively to the main frame*, with mechanical transmission from one main steam engine or each with a separate steam engine.

Mr. Weiler, ministry of public works, Siam. (In German.) — In talking of the design of the locomotives, the reporter has considered the influence of the line, that is to say the curves, the gradients and the gauge of the line. I ask whether it is not also desirable to mention the influence of the maximum moving dimensions, the loading gauge. The more room the designer has available, the easier it is to succeed in obtaining powerful engines.

In Prussia, the State prescribes exactly the same standard loading gauge for tracks with gauges of 60 and of 75 centimetres (1 ft. 11 5/8 in. to 2 ft. 5 1/2 in.). That seems illogical. It seems to me that the 75-centimetre (2-ft. 5 1/2-in.) track should have a larger loading gauge. I do not know what is done in this way in other countries. But it would be interesting to examine generally the influence of the standard loading gauge on these types. It is certainly possible to design, for a smaller loading gauge, a locomotive having the same power as one for a larger loading gauge, but the design will be more complicated and more expensive. Consequently, it would probably be necessary to know also the cost of the locomotives in order to make a comparison, for it is exactly on narrow-gauge lines that this question is of importance. That is what I wished to remark.

Mr. Jesser, *reporter*. (In German.) — I have certainly thought of this. According to what I know of the conditions existing in the countries which I know, the State has fixed *a priori* the loading gauges for tracks of each gauge, and exceptions must be rare. Consequently, I thought it useless to investigate what locomotives could be put in use on narrow-gauge lines with larger loading gauges, because it seemed to me improbable that the government would authorize the use of a greater loading

gauge than that now specified. The point may be important in countries in which regulations of this kind do not yet exist. But I have not considered it from this point of view, I have taken the loading gauges such as they exist.

The President. (In German.) — The president of the 2nd section asks us to join that section where motor cars are going to be discussed. He thinks it very important that we should take part in the discussion of this question which is closely related in sundry respects with that of the locomotives. I think that we ought to accept that invitation. (*Approval.*)

— The meeting adjourned at 10 a. m.

Meeting held 6 July 1910 (afternoon).

—

MR. VON ZIFFER, VICE-PRESIDENT IN THE CHAIR.

The President. (In French.) — I declare the meeting opened. We will resume the discussion of question XIX.

Does anybody else wish to speak?

Mr. de Burlet, *vice-president.* (In French.) — I wish to obtain some information from the honourable reporter.

On page 47 of his report (1) he states that on adhesion lines there are gradients of 5·88, 70 and 82·5 per mil. That seems to me tremendous. Can he perhaps tell us on what lines these gradients exist, operated by simple adhesion locomotives, and whether there is also a goods service on these lines?

Mr. Jesser. (In French.) — These gradients are on an American line, having a gauge of 914 millimetres (3 feet).

This line is chiefly used for the carriage of goods, of minerals.

Mr. de Burlet. (In French.) — That seems extraordinary! It is probable that the heavy traffic is in the downhill direction. One cannot explain it in any other way.

Mr. Jesser. (In French.) — The locomotives are very powerful.

Mr. de Burlet. (In French.) — They probably also have special brakes.

Mr. Jesser. (In French.) — 500 horse-power.

Mr. de Burlet. (In French.) — Many thanks for this information.

Mr. Jesser. (In French.) — You will find more detailed information about this subject in the appendix.

Mr. de Burlet. (In French.) — Another figure has struck me. On page 48, 2d column, speeds of 50 and 65 kilometres (31 and 40·4 miles) per hour are mentioned. These two numbers seem to me excedingly high for secondary lines. There are few countries where such speeds are authorized by the rules in force.

Mr. Jesser. (In French.) — In Sweden we find, for a gauge of 890 millimetres

(1) See also *Bulletin of the Railway Congress*, 1910, July, p. 3163.

(2 ft. 11 3/64 in.), curves having radii of 150 metres (7 1/2 chains), and maximum speeds of 50 (31 miles), and then of 57 kilometres (35·4 miles) per hour.

Mr. de Burlet. (In French.) — Then one is authorized to run at speeds twice to three times those allowed elsewhere, particularly in Belgium, where we are not allowed to run at more than 30 kilometres (18·6 miles) per hour in the country...

The President. (In French.) — In Austria, 40 kilometres (24·8 miles) per hour.

Mr. de Burlet. (In French.) — ... and at more than 10 to 12 kilometres (6·2 to 7·5 miles), according to circumstances, in populous places.

Mr. Chassin, French Southern Railway. (In French.) — In France, the speed on narrow-gauge lines can attain 40 kilometres (24·8 miles) per hour; that is so on the French Southern Railway, in particular.

We have gradients of 30 per mil and curves with a minimum radius of 150 metres (7 1/2 chains). In order to operate these lines, we have locomotives with three coupled axles and leading bogie, and Mallet locomotives for goods.

The line from Nice to Digne, to be opened in 1911, length 150 kilometres (93 miles), with gradients of 30 per mil, will have express trains attaining a speed of 45 kilometres (28 miles) per hour.

Mr. de Burlet. (In French.) — Those lines are laid, are they not, on a road-bed of their own?

Mr. Chassin. (In French.) — Naturally. I am speaking of secondary lines having a gauge of 1 metre (3 ft. 3 3/8 in).

35 to 40 kilometres (21·7 to 24·8 miles) per hour are ordinary speeds.

Mr. de Burlet. (In French.) — Are there level crossings which are not guarded?

Mr. Chassin. (In French.) — Some are guarded, others are not.

Mr. de Burlet. (In French.) — Even with such speeds, there are level crossings which are not guarded?

Mr. Chassin. (In French.) — Certainly, but there are notice-boards cautioning the public to look out before crossing the line, and giving the times at which trains are due to pass.

The President. (In French.) — In Austria, we have the speed of 40 kilometres (24·8 miles) per hour, and we also have level crossings which are not guarded.

Mr. Francis Level, Anvin-Calais Railway. (In French.) — In France, regulations as to speed are only made for lines laid on public highways.

Mr. Girtanner, Federal department of posts, and railways, Switzerland. (In German.) — In Switzerland, the speed on narrow-gauge lines is fixed by an order of the Federal Council dated 10 March 1906; it varies between 45 kilometres (28 miles) per hour as maximum for trains equipped with the continuous brake, and with gradients attaining 15 per mil, and 18 kilometres (11·2 miles) per hour for trains without continuous brake, with gradients attaining 70 per mil and curves with a radius of less than 60 metres (3 chains), with a minimum of 40 metres (2 chains). These rules apply to lines on an independent road-bed. The speed is much less on the lines laid on public high-

ways. In such cases, it must not exceed 12 kilometres (7·5 miles) per hour when passing through populous places, in the narrow streets of towns and villages, in order to attain its maximum of 25 kilometres (15·5 miles) per hour in the open country, between the populous places. In considering these figures, it must not be forgotten that these speeds must be reduced still further, in accordance with the gradients, in the open country : on gradients of over 30 and up to 50 per mil, it must not exceed 20 kilometres (12·4 miles) per hour; up to 70 per mil, 15 kilometres (9·3 miles) per hour; up to 90 per mil, 12 kilometres (7·5 miles) per hour; over 90 per mil, 8 kilometres (5 miles) per hour. On curves having a radius of less than 75 metres (3 $^{3}/_{4}$ chains), the maximum speed must in no case exceed 20 kilometres (12·4 miles) per hour. Thus there is a considerable reduction of speed here.

Mr. de Burlet. (In French.) — That is nearly the same as with us.

Mr. Ch. Masson, Visp-Zermatt Railway, Switzerland. (In French.) — However these speeds are considerably reduced, according to gradient, to 12 and 8 kilometres (to 7·5 and 5 miles) per hour.

The President. (In French.) — Does anybody else wish to speak?

We will now discuss and vote the conclusions.

This is the first clause :

" **Locomotive suited to the character of the line and of the traffic on narrow-gauge railways.**

" A. — *The design of new narrow-gauge lines which are to be operated with steam locomotives, are to be used for public traffic, and have to deal with a considerable amount of passenger or goods traffic.*

" 1° In all the cases in which the selection of the gauge of a new line is not decided in advance by its immediate junction with another line or by some other administrative connection with an existing narrow-gauge system, a gauge of 1 metre (3 ft. 3 $^{3}/_{8}$ in.) is considered the best. A smaller gauge than 600 millimetres (1 ft. 11 $^{5}/_{8}$ in.), and the selection of a new gauge which does not yet exist, are not to be recommended."

— Adopted.

" 2° In the case of adhesion lines, whose locomotives work without any artificial increase of friction, it appears as a rule advisable not to have steeper gradients than 40 per mil."

Mr. George Level, General Light Railway Company, France. (In French.) — 40 per mil, that seems to me rather excessive.

Mr. Jesser, *reporter*. (In French.) — Do you wish to increase it?

Mr. de Burlet. (In French.) — No, no!

The wording runs : " It appears as a rule advisable... " Thus it is a qualification. Further qualification is unnecessary.

— Clause 2 is adopted.

The President. (In French.) — " 3° It is recommended as a rule not to have curves with a radius of less than 40 metres (2 chains), if the vehicles are not specially designed for sharper curves. It is desirable to have the straights between the super-elevation gradients of reverse curves, which

are not equipped with guard rails, not shorter than the greatest existing distance between the bogies of a vehicle."

Mr. Schaetz, *secretary-reporter*. (In French.) — As regards curves having a radius of 40 metres (2 chains), I wish to state that in my opinion a higher figure should be recommended as minimum limit. We here must represent the point of view of operation rather than that of construction. The constructor already has sufficient inducement to reduce the radii of the curves in order to reduce the cost of construction of the line.

Working expenses are never sufficiently considered in scheming new railway lines and there is too much tendency to calculate the cost of construction only. Sharp curves cause quick wear of the tires and the rails, and working very soon becomes expensive.

It is stated that « it is recommended as a rule not to have curves with a radius of less than 40 metres (2 chains), if the vehicles are not specially designed for sharper curves. » The locomotives must be constructed to suit the tracks, and not the tracks to suit the locomotives which are not yet built.

The proposed wording seems to me rather illogical. We cannot, however, recommend such a low limit for the radius of curves, solely in order to utilize vehicles which can round run sharp curves. There is, on the contrary, every advantage, even if such vehicles have to be used, to have lines which only have sharp curves at the points where this is absolutely necessary.

Naturally there are cases where existing rolling stock must run on new branches; but as a rule, it is new rolling stock which runs on a new line.

I propose to say : " and not to go below this limit except when it is absolutely necessary, at certain points, to have sharper curves put in."

On the other hand, the wording proposed would seem to recommend that all lines should have curves with radii of 40 metres (2 chains). I think that we should not go below 80 metres (4 chains).

Mr. George Level. (In French.) — I ask that the minimum radius should be fixed at about 80 to 90 metres (4 to $4\,^1/_2$ chains).

Mr. Jesser. (In French.) — I took 40 metres (2 chains) as minimum, because among the locomotives about which I received information, there are many which can negociate such curves without much difficulty. You will find information about this on page 68 of my report (1).

The President. (In French.) — Do you propose anything, M. Schaetz?

Mr. Schaetz. (In French.) — I uphold my original opinion. One can very well build, without much trouble, lines with no curves of smaller radius than 80 metres (4 chains). If one goes as low as 40 metres (2 chains), this must only be in case of necessity, for instance in order to avoid having to build expensive constructive works.

Mr. de Burlet. (In French.) — Is it necessary to name a figure? The radius of the curves is so closely connected with the local topographical conditions and they vary widely from one district to another.

(1) See also *Bulletin of the Railway Congress*, 1910, July, p. 3184.

Mr. Chassin. (In French.) — As a rule, it is better to have curves with a radius of at least 80 metres (4 chains). They give much better running, and the wagons and the locomotives can have longer wheelbases. It has to be noted that when there are curves with a radius of 40 (2 chains) or even 60 metres (3 chains) on the open line, the outer rails and the flanges of the wheels become worn extraordinarily quickly.

Besides, there is no question of an injunction, but merely of a recommendation.

Mr. de Burlet. (In French.) — In my opinion, the laying out of the lines should be such as to give the curves as large radii as possible. It is clear that there are greater difficulties in traction and real troubles in the case of lines with sharp curves ; a material increase in the working expenses results. If then one goes as low as 40 metres (2 chains), it is because it is impossible to do otherwise except by spending excessive sums on the construction of the lines ; but, on the other hand, there is a certain danger in fixing a minimum of 80 metres (4 chains) as a general rule. If that figure is given, it may give trouble at a given moment. If an administration proposes a scheme with curves of 50 or 60 metre (2 $^1/_2$ or 3 chains) radius, it will be told : you must not go below 80 metres (4 chains) ; this figure has been fixed by the International Railway Congress, with all the authority attached to its decisions. That is why I think it is better not to give a definite figure.

Mr. Schaetz. (In French.) — What has struck me in the proposed text, is the figure of 40 metres (2 chains) recommended as a lower limit. One can easily gather from the present discussion the limit which seems most suitable, and I am of opinion that no figure should be given in the proposals of the section.

Mr. de Burlet. (In French.) — Just as there is a disadvantage in fixing 40 metres (2 chains) as a limit, so there is another in fixing 80 metres (4 chains) as a limit. Let us simply record our general opinion, I think unanimous opinion, that in planning the line the curves should be given as large radii as reasonably possible.

Mr. Jesser. (In German.) — I venture to remark that the German *Verein*, which as we know specifies very strict conditions, has prescribed a minimum radius of 40 metres (2 chains) for lines having a gauge of 750 millimetres (2 ft. 5 $^1/_2$ in.). I think that the Congress of the railways of the whole world should not be more strict than the German *Verein*, especially as, as has already been stated, the table includes a number of rather sharp curves, and as locomotives with six coupled wheels run without trouble over curves having radii of 40 (2 chains), and even of 25 metres (1 $^1/_4$ chains). It must finally be remembered, that according to the further prescriptions, rigid wheelbases, with axles not radial at all, are admissible up to 1·5 metres (4 ft. 11 in.) for locomotives and up to 1·8 metres (5 ft. 11 in.) for vehicles. These wheelbases suffice perfectly for an ordinary locomotive with three coupled axles which is not called upon to do any exceptional work. If greater power is to be obtained (and in Austria they have succeeded in obtaining nearly 300 horsepower), this can be done by using carrying axles. It is true that locomotives of

this kind cannot be expected to give a big tractive effort. However, a whole series of types have been mentioned which also satisfy the latter condition. The simplest system is the Klien-Lindner system which makes it possible to use Locomotives with four coupled axles on curves of such radii. I certainly think that no permament-way engineer who goes to the conclusions of the Congress for guidance will be able to conclude that he must everywhere use curves having a radius of 40 metres (2 chains) as soon as there is some small obstacle. But he must be able to go down to 40 metres (2 chains) if he is in a ravine or on the steep flanks of a mountain and if a crossing involves a long viaduct or bridge.

That is how I understand the matter. It is very possible that I have not succeeded in making the text as clear as it should be; but owing to the concise wording that the conclusion should have, it is very difficult to express all ideas. I only desired to recapitulate them, and I leave it to the section now to come to the necessary decisions.

Mr. Weiler. (In German.) — I think that the first clause, which states that a gauge of 1 metre (3 ft. 3 3/8 in.) is to be preferred to a smaller gauge, already expresses the idea that smaller radii are also tolerated. In fact, the reporter specially mentions that locomotives can now be constructed in such a way as to be able to run round the sharpest curves. Consequently, it is no longer necessary to select a smaller gauge. If it is desired to increase the radius, then the first clause should be struck out; one cannot stand without the other. But I believe that many administrations of minor lines are anxious, as you have already been told, not to have too small radii.

I have been told that the Otavi line, which has a gauge of 60 centimetres (1 ft. 11 5/8 in.) and a length of 600 kilometres (373 miles), is now having the radii of its curves increased because large radii are preferred, with a view to the maintenance of the track and of the rolling stock; and it is thought preferable to incur a certain expenditure for this purpose.

Mr. C. Sapin, Côtes-du-Nord Railway, France. (In French.) — I ask, as a tendency towards leasing has been shown, that it should not be made possible for future railway owners to compel us to operate under onerous conditions. We must try to operate as cheaply as possible, and is that why when schemes for building narrow-gauge lines are being worked out, it is above all necessary to consider the ease and economy of the working; it is above all necessary not to sacrifice these elements to considerations of economy in prime cost.

I think it would be preferable not to fix a figure.

Mr. Jesser. (In German.) — Perhaps it is possible to find an intermediate statement in order to meet all wishes. One can say that a minimum radius of 80 metres (4 chains), often mentioned, is recommended, but that this limit can be reduced to below 40 metres (2 chains) if the rolling stock is specially designed for running round such curves.

Mr. de Burlet. (In French.) — This is the wording I propose: " It is agreed to recommend that the line should be planned so as to have curves of as large a radius as possible. It is only in case of

absolute necessity that one can go far down to 40 metres (2 chains) as radius, unless the vehicles are specially equipped." (*Protests.*)

Mr. Chassin. (In French.) — Strike out the part about the vehicles; the rest is all right.

Mr. de Burlet. (In French.) — Very good. Accordingly we strike out the words: "unless the vehicles are specially equipped". In any case, the first part of the text seems to me to meet all wishes very well.

Mr. Francis Level. (In French.) — It is better to specify no figure.

Mr. de Burlet. (In French.) — It is said: "It is only in case of absolute necessity".

It seems to me that my wording is of a kind to satisfy everybody, but I clearly see that we are in the presence of a good number of operators (*Laughter*); however, the latter do not as a rule buy a pig in a poke, if I may use that slang phrase. When they apply for a working lease, they know the scheme, and they fix their conditions in accordance with the technical conditions under which the line is built or is going to be built; at least such is the case with us. We never arrange for the leasing of a line before the plans have been completed and even before the line is nearly finished. The lessee accordingly has full information; if there are curves with a radius of 40 or 50 metres (2 or 2 1/2 chains), he fixes his conditions accordingly.

My own conviction is that I have already gone very far in saying: "It is only in case of absolute necessity that one can go to 40 metres (2 chains)." I thus give lessees, who are defended very eloquently here, a satisfaction which should suffice, and I show that I am conciliatory.

You will be quite well enough equipped, gentlemen, to be able to dispute matters with the engineers of departments and to prove that there is no necessity, and even if there is necessity, you will maintain that it is not absolute, and perhaps you will be right.

The President. (In French.) — There seems to be agreement. (*Signs of approval.*)

Mr. de Burlet. (In French.) — We will try to find for the decisive text, an even more forcible expression.

The President. (In French.) — Thus we are agreed as to principle, subject to drafting clause 3 in such a way as to allow for the desiderata expressed.

We now pass to clause 4:

"4° If a busy traffic has to be dealt with, it appears advisable to build the road and road-bed of a line having a gauge of 1 metre (3 ft. 3 3/8 in.), of such a strength that it can stand an axle-load of 10 tons (9·84 English tons); it is recommended, particularly in the case of lines with steep gradients and sharp curves, to provide for greater axle-loads."

Mr. de Burlet. (In French.) — The last sentence does not seem to be quite clear. It states that this recommendation applies in particular to lines with steep gradients and sharp curves, that it is advisable to build for relatively heavier axle-loads. Would it not be better to say: "In the case of lines with steep gradients and sharp curves, it is advisable to build the tracks so as to suit axle-loads exceeding 10 tons?"

Mr. Jesser. (In French.) — We agree. The wording of this clause shall be modified accordingly.

— Adopted.

The President. (In French.) — This is the second part of the conclusions :

" B. — *As regards the design of new locomotives.*

" 1° The following may be recommended in order to increase the power of locomotives :

" *a*) The use of a working pressure of up to 14 atmospheres ;

" *b*) Superheating the steam to 300° C. (572° Fahr.) ;

" *c*) Compounding."

Mr. Chassin. (In French.) — Why is 300° C. (572° Fahr.) mentioned? I propose that no figure should be given.

Mr. Jesser. (In German.) — I thought that we ought not to recommend any greater superheat, for one knows that superheated steam strongly attacks sundry details of the locomotive, especially stuffing boxes and slide valves. I was of opinion that we ought to recommend only the superheat used up to the present without trouble by the administrations belonging to the Congress. It is quite possible that later on one may succeed in constructing stuffing boxes and slide valves, able to stand higher temperatures ; in particular, the tubes are exposed to temperatures appreciably higher than those attained by the steam. I consider any further increase in the temperature as an experiment for the future, and I think that superheating up to 300° C. (572° Fahr.) can readily be adopted. Everybody is free to make experiments about the limits to which it is possible to push superheating. I personally have watched superheating experiments made with stationary boilers. Temperatures of 320° and 330° C. (608° and 626° Fahr.) were reached, and things went very well. In my opinion it is prudent, in a way, to indicate a limit, so that those who are not familiar with the subject may not use too high temperatures, without knowing that they are exceeding the usual limit.

Mr. de Burlet. (In French.) — It is better to give no figure. One is still in the experimental period, particularly as regards secondary railways.

We have constructed and sent to the Brussels exhibition a locomotive of the superheating type for use on light railways.

Mr. C. Sapin. (In French.) — I am of opinion that it would be better to recommend the continuation of investigations, so as to make it possible later on to examine the results obtained, and to ascertain whether it is advisable to develop the use of compounding and of superheating.

Mr. Chassin. (In French.) — Let us not fix a figure.

Mr. de Burlet. (In French.) — We made trials during six months before sending the locomotive I have mentioned to the exhibition. I must say that we obtained good results and we have ordered a second locomotive of the same type ; but I repeat, we are still in the experimental period.

Mr. Jesser. (In German.) — I think the use of superheat up to this temperature can very well appear in our conclusion otherwise than as an experiment, as we know that the Swedish State Railway has been using such superheating since 1906,

without having found any objectionable effects. It would accordingly be wrong to say that it is but an experiment; I think, on the contrary, that up to a temperature of 300° C. (572° Fahr.) the question may be considered definitely solved and superheating applicable without other restrictions.

Mr. de Burlet. (In French.) — It would be preferable not to limit the experiments to this figure.

I think we agree that the phrase : " up to 300° C. (572° Fahr.) " should be struck out. (*Signs of approval.*)

— Clause 1 as amended is adopted.

The President. (In French.) — This is clause 2 :

" 2° On lines on which the following curves frequently occur on the open line, no greater rigid wheelbases should be used than those given in the following table :

RADIUS OF CURVE.	RIGID WHEELBASE.
25 metres (1 1/4 chains).	1·4 metres (4 ft. 7 1/8 in.).
40 metres (2 chains).	1·8 metres (5 ft. 10 7/8 in.).
50 metres (2 1/2 chains).	2·0 metres (6 ft. 6 3/4 in.).
75 metres (3 3/4 chains).	2·5 metres (8 ft. 2 7/16 in.).
100 metres (5 chains).	2·9 metres (9 ft. 6 3/16 in.).
125 metres (6 1/4 chains).	3·3 metres (10 ft. 10 in.).
150 metres (7 1/2 chains).	3·6 metres (11 ft. 9 3/4 in.).
180 metres (9 chains).	3·9 metres (12 ft. 9 9/16 in.).

Mr. de Burlet. (In French.) — These figures seem to me to be well established. I propose to accept them.

Mr. C. Sapin. (In French.) — I propose that the figure 25 (1 1/4 chains) should be struck out.

Mr. de Burlet. (In French.) — Yes, Mr. Operator, we will strike it out. (*Laughter.*) Those who have curves with radii of 25 metres (1 1/4 chains) can examine what wheelbase is suitable; that will be in better agreement with our discussion about the radii of curves.

— Clause 2 as amended is adopted.

Mr. de Burlet. (In French.) — We have to decide about the following clauses :

" If the adhesive weight necessary cannot be obtained inside the limits set by these wheelbases and the admissible maximum axle-loads, then, according to the excess required, the following arrangements can be recommended :

" *a*) Lateral play;

" *b*) Not having flanges on some of the pairs of coupled wheels; if these measures do not suffice, then;

" *c*) Having some of the coupled axles radially adjustable; and, finally;

" *d*) The use of one or two motor bogies movable relatively to the main frame, with mechanical transmission from one main steam engine or each with a separate steam engine."

That gives a choice between different measures; that commits nobody and cannot inconvenience any administration.

Mr. du Beaufret, Bône-Guelma Railway, Algiers. (In French.) — It seems that the word " bogie " is generally held to mean

that there are two axles. Now there are narrow-gauge locomotives with six axles. It would perhaps be better to say "truck".

Mr. de Burlet. (In French.) — That remark is quite corect.

— Adopted with this modification.

The President. (In French.) — We pass to the next section of the question :

" Is it advisable to protect the wheels and the moving parts by a metal cover? "

Mr. Jesser. (In German.) — The discussion of the chief question, that of the latest types of locomotives, which is from many points of view the most interesting and most important one, being now concluded, we pass to the supplementary questions, the first being whether *it is advisable to protect the wheels and the moving parts by a metal cover*.

Twenty-eight administrations sent answers to the list of questions; twelve of them limit themselves to the statement that they do not use such covers, although some of them operate lines which also use public highways. The sixteen other administrations give more or less detailed information, of which I will give a summary. The proportion of answers in the affirmative to answers in the negative is as 7 to 7. Such covers are considered useless by two administrations whose locomotives originally had covers which later on were removed, and by another administration which continues to use the covers. The lines of these three railways are in part on public highways. In one of these cases, it is stated that the fact that covers of the ordinary type are not really dust-proof, is the cause of the uselessness of the cover. In addition, there are four administrations which do not use covers, two which use public highways; these think that such covers are unnecessary.

Of the seven administrations which are in favour of covers or consider them useful six use this means of protection on their locomotives and one does not use it; two do not utilize public highways and one uses covers in order to economize in cost of lubrication and maintenance, as otherwise the dust whirled up from the ballast would have a deleterious influence on the mechanism.

It is evident that these contradictory opinions are not due merely to the varying importance attached by the different administrations to the advantages and disadvantages of the system, but chiefly to the different conditions of working. Besides the quantity of dust which has to be considered in each individual case, the physical properties of the dust, particularly the hardness of the material out of which it is formed and the size of its particles, play an important part.

These reasons make it impossible to give a general answer to the question; it will vary in each individual case, in accordance with the factors which come into play.

The answers received make it possible to draw the following general conclusion : the use of a cover for the wheels and the moving parts of the mechanism has as chief object the protection of the rubbing surfaces against foreign bodies, especially dust.

As secondary objects, it may be mentioned that such locomotives scare horses, whether driven or ridden, less and in cases of grazing vehicles or of collision with animals or persons, less damage is done.

On the other hand, the presence of coverings makes it more difficult to look after the engine, particularly at wayside stations with short stops, and care should be taken to design the coverings so as to provide for the easy accessibility of the mechanism.

If the locomotives are exposed to much dust consisting of hard particles the use of protective coverings is to be recommended and these, in order to be effective, must be as dust-proof as possible and enclose the whole mechanism.

Accordingly I have drafted the following text, which I propose to you as conclusion :

1° Locomotives which are liable to suffer from an unusual amount of dust, can have their moving parts protected by a covering, which is to enclose, as far as possible, all the moving parts, and is to be as dust-proof as possible. Doors are to be provided in this covering so as to make the moving parts as accessible as possible;

2° Such coverings may also help to some extent to prevent the scaring of draft animals and to reduce damage in cases of collision with other vehicles, animals and persons.

Mr. C. Sapin. (In French.) — The reporter states that he received seven answers in favour and seven answers against. Now, when I look at page 6 of the report (1), I find that forty-four administrations are mentioned. Accordingly thirty have refrained from answering. To sum it up, this proves that coverings for the mechanism are used by seven companies out of the forty-four which have answered.

Consequently, this question lacks actuality.

Dust is mentioned. Seeing that secondary railways are more and more adopting somewhat faster speeds, there is every reason that the driver should be able to see, while running, the exterior mechanism.

The question of scaring animals by the sight of the mechanism has been mooted; but that is now of little importance, for motor cars merit that reproach to a far greater degree than the railways on highways. Now that motor cars are overrunning the roads, the secondary railways can no longer be considered monsters. (*Laughter.*)

Let it therefore not be said that our railways are able to scare draught animals.

Mr. Ch. Masson. (In French.) — Then the second clause of the conclusion should be struck out?

Mr. de Burlet. (In French.) — That remark is well founded. I think that we agree to strike out clause 2. (*Signs of approval.*)

Clause 1 is adopted.

Mr. Jesser. (In German.) — The second supplementary question is that of knowing whether *it is advisable to have a footplate on each end of the locomotive.*

Twenty-four administrations have sent answers about this subject. Nineteen of them state that their locomotives have only one footplate, and thirteen of these express no opinion about the usefulness of this arrangement, while the six others state that the double footplate is unneces-

(1) See also *Bulletin of the Railway Congress*, 1910, July, p. 3122.

sary, considering their traffic conditions; one administration states that it is not to be recommended.

Thus there are five administrations who have given an answer in the affirmative.

The administration of the Bavarian State Railway has tank locomotives with two cabs, connected with a passage way round the locomotive; at each end there is a gangway by means of which the employees on the train can reach the locomotive, while it is running. Provided that the other regulations in connection with this point are duly observed, locomotives of this kind may be driven by one single man. This naturally reduces the cost of traction.

In the case of railways which utilize roads or streets where there are numerous cross-roads and where there is much traffic it appears necessary, according to expert opinion, to make provision to enable the driver to see not only his track a sufficient way ahead but also as much as possible the streets crossing that on which the track is laid. If it is desired to save the cost of building and of operating turntables, as well as the time necessary for turning locomotives, so that the cab may always be frontways while running, it is possible to have either a central raised cab in the case of tracks of short length, without large-capacity boilers, or two cabs, one at each end of the locomotive.

In the types, drawings of which were sent by a Belgian administration and a French administration, the operation of the regulator and of the reversing gear can be effected from each of the two cabs without much complication of levers and rods. This solution may be considered the best for the object aimed at, as it enables the driver to have a good view of the street traffic.

A very noteworthy similar solution is reported to us by the Great Western Railway (England); strictly speaking it does not fall within the scope of this question, but nevertheless it has a similar object in view. It is intended for use on a standard-gauge line having its own road-bed, but can also by applied without modification to a narrow-gauge line; hence I mention it here. A train consisting of two carriages and a tank locomotive is coupled up permanently so as to be able to run in either direction, the locomotive always remaining between the two carriages. A mechanical rod and lever transmission makes it possible to operate the regulator from either of the two cabs which are at the two ends of the train, each of the carriages having a cab or driver's compartment at one end. While running, the driver is in that cab which is at the head of the train, and the fireman is on the locomotive. There is no provision for passing from the carriages to the locomotive while the train is running; the employees on the train communicate with each other by means of whistle and bell signals. This arrangement makes it possible for the driver to have a perfectly clear view of the track and makes it unnecessary to turn the locomotive to shift it to the head of the train; hence it seems suitable, in the case of a shuttle service on short lines where the direction of running is frequently reversed, for it saves not only the time which would be required for shunting operations, but also the station line which would have had to be kept clear, then becomes available for other purposes.

We now can pass to the conclusions which naturally fall into three divisions and which run as follows :

1° In the case of lines which use streets in thickly-populated towns with much traffic, it is advisable to arrange matters, so that the driver can in good time obtain an unobstructed view of any side streets crossing the line.

If it is not possible always to turn the locomotives so as to be head on, it is advisable to have a cab at each end of the locomotive; it must be possible to operate the regulator and the cut-off from each cab, and to give the necessary signals.

Tractors with a raised cab, from which an unobstructed view can be obtained in every direction, satisfy this requirement without any need for turning them;

2° If the locomotive crew is to consist of one man only, it must be possible to pass from the train to the locomotive while running; this can be effected in the case of tank locomotives by having two footplates with gangway connections. Only one of the footplates need be equipped for driving;

3° In the case of a shuttle service with a train of two carriages running on its own road-bed the locomotive can be placed in the middle, if it is possible to operate at least the regulator and the brakes from the carriage-cabs at the ends of the train.

Mr. du Beaufret. (In French.) — The wording of clause 1 is too absolute. To lay down the principle that the driver must watch the cross streets, means stopping the railway. The train must be able to continue its journey.

Mr. Jesser. (In German.) — I think that the French text does not exactly represent the meaning of our wording. No doubt it is more difficult to make a good translation than is generally thought. I said in German : " Für Bahnen, welche Strassennetze in verbauten Ortschaften mit dichtem Verkehre benützen, " and it is perhaps possible to translate this more accurately into French than by the phrase here given : " Dans des rues..."

Let us consider our tracks in many towns, where one is often compelled to pass through streets which are so narrow that there is barely room for a street vehicle and a tramway. Side streets cross this street, and through them cabs and large carts arrive at a trot. It will be impossible to avoid accidents, if the driver cannot stop within a short distance, in other words, if he does not see in good time the vehicles which are crossing. I request those of my colleagues who know French better than I do, to select a phrase which will clearly express the idea I have just explained.

Mr. du Beaufret. (In French.) — It is a question of the wording. I do not claim that the driver should not look out for what happens at crossings.

Mr. de Burlet. (In French.) — It is said that : " it is *advisable* to arrange matters, so that the driver can in good time obtain an unobstructed view of any side streets crossing the line. "

It seems, according to this text, that he is not *obliged* to watch the streets he passes. Evidently nobody has this idea, and in order to make the meaning more clear, I propose to say : " It is advisable that the driver should have a free view of of the track, particularly where streets cross. "

He must evidently look out everywhere but especially so where streets cross.

Mr. du Beaufret. (In French.) — Quite so.

Mr. de Burlet. (In French.) — When one says " streets " that means populous places. (*Signs of approval.*)

Mr. C. Sapin. (In French.) — As for the cabs...

A delegate. (In French.) — We are at clause 1. What is decided?

Mr. C. Sapin. (In French.) — ... the French railways use double cabs very little. The presence of the driver in front can be useful if the railway uses the public highway over the greater part of its length; but if it only uses it exceptionally, the case is not the same. For instance, if a railway runs for 1 kilometre (0·62 mile) through a town where there is much traffic, out of a total length of 100 kilometres (62 miles), then it is not necessary to have two cabs.

Mr. de Burlet. (In French.) — You allow danger to continue on one part of the line when you know that it exists!

Mr. C. Sapin. (In French.) — But if it is an exception?

Mr. de Burlet. (In French.) — No matter! Where danger exists, even if concentrated at one short part of the line, the necessary precautions must be taken. On our railway system, I do not wish the driver to be at the back at any point whatever.

Mr. C. Sapin. (In French.) — You assume the railway constitutes a danger; but taking the progress of road locomotion into consideration, it is no more a danger than a tramway or a motor car.

Mr. de Burlet (In French.) — The railway is a danger, like a motor car. All those who drive a locomotive, a motor car, any vehicle, even those who drive horses, have to exercise particular care. I do not assert that the danger is so great that railways, motor cars, carriages, etc. should not be allowed to circulate in the streets, but these means of locomotion in the streets necessitate special precautions, and one of these is that the driver or watchman should be at the head of the train. If he is behind, it is impossible for him to see what happens on the rails. His line of sight only extends horizontally. Should a child be on the track, he cannot see it in good time and an accident necessarily happens. I have often intentionally travelled in locomotive cabs, in front and behind, when passing through villages or towns, in order to become fully acquainted with the subject. After the personal experience which I have acquired, I would not take the responsibility of authorizing the driver to be at the back of the locomotive! I do not admit that because no danger exists on the greater part of the run, therefore the precautions necessary should not be taken where the danger exists.

I therefore would urge that the wording proposed by our distinguished reporter, Mr. Jesser, should be adopted.

Mr. Jesser. (In German.) — I also think that it would be very easy to avoid the case the former speaker has mentioned. On a line which has long sections on public highways and which passes through a town, it must always be possible to turn the locomotive at the terminus, so that the driver is again in front. It is only in the case of lines where the density of the traffic is such that there is no time to turn

the locomotive, on those, for instance, which run through a town, that it is necessary for the driver to be in the cab in front. If the locomotive can be turned, it is unnecessary to have a second cab. But one or the other arrangement is indispensable.

M. de Burlet. (In French.) — Do you insist, Mr. Sapin?

Mr. C. Sapin. (In French.) — You say that there is danger. Our public administrations in France take every precaution necessary from this point of view. Thus in the Haute-Saône, two-cab locomotives are used on the first railway system. On the second system, they are not used, as it was thought better to leave the driver at the back ; but safety was provided for by reducing the speed accordingly. Thus there are speeds of 6 kilometres (3·7 miles) per hour. With his brakes the driver, even at the back, can at once stop his engine.

Mr. de Burlet. (In French.) — At the back, he does not see what happens in front of his engine.

Mr. C. Sapin. (In French.) — To recommend the double cab would be a disadvantage which would be recognized later on.

Mr. Jesser. (In French.) — We turn the locomotive; then the driver is in front.

Mr. C. Sapin. (In French.) — Then it is permanently running backwards!

Mr. Jesser. (In French.) — During half the mileage of the locomotive.

Mr. C. Sapin. (In French.) — You must always return with the back in front.

Mr. Jesser. (In French.) — That does not matter.

Mr. C. Sapin. (In French.) — Your driver is very badly placed.

Mr. Jesser. (In French.) — I have often done this; it is very easy.

Mr. C. Sapin. (In French.) — Let us say : "It is to be advised." The text is too absolute.

Mr. de Burlet. (In French.) — I see nothing to change in the text.

Mr. C. Sapin. (In French.) — Do we agree in principle?

Mr. de Burlet. (In French.) — It is a question of degree. Much money has been spent in equipping the vehicles with continuous brakes. Now the first condition necessary to make them effective, is that the driver who is to work those brakes should be able to see the rails and at once perceive any obstacle which may turn up. That is only possible if he is in front. I repeat and assert it as a fact that the driver, if at the back, cannot see the rails in front of his engine properly, at those points where an unexpected danger may turn up at any moment.

Mr. Philippe, Belgian Northern Railway. (In French.) — By doing away with the front cab, you shorten the length of the engine and you improve the outlook of the driver. If you place the driver and the fireman in the same cab at the back, they can both help in the watching of the track. In the case of engines with two cabs, although the driver can see better, the fireman cannot see so well. That seems to me to be worth mentioning. On

the other hand, as regards the management of the fire and of the boiler, do you not think that in certain cases there may be a serious disadvantage in separating the fireman from his driver, who is more skilful than he is?

There are instances which I wish I had time to mention as supporting Mr. Sapin's views.

To sum up, it is advisable not to be too absolute in the conclusions.

Mr. C. Sapin. (In French.) — Why not try to work out a design for a steam locomotive of the kind similar to electric locomotives, that is to say, one in which the driver and the fireman are always in front? That question can be solved without complications. Nothing compels us to have the fire always at the back ot the locomotive.

Mr. de Burlet. (In French.) — We cannot put this into a conclusion.

Mr. Philippe. (In French.) — The question of the driver has been settled on standard-gauge railways. There are locomotives on which the driver has two sets of driving appliances at his disposal. Thus he always has, ready to hand, whether running in one direction or the other, his regulator, his reversing gear and his brake.

Mr. du Beaufret. (In French.) — One could say : " it is advisable..."

The words : " it must be possible..." are too absolute.

Mr. de Burlet. (In French) — Do you agree, Mr. Reporter?

Mr. Jesser. (In French.) — Perfectly. One could find another phrase.

Mr. de Burlet. (In French.) — Do you recommend that the locomotive crew is to consist of a single man?

Mr. Jesser. (In French.) — Yes.

Mr. de Burlet. (In French.) — I do not!

Mr. Jesser. (In French.) — It is to be recommended that it should be possible for the train men to pass from the carriages to the locomotive while the train is running.

Mr. de Burlet. (In French.) — When will they reach it? When the accident has happened?

Mr. Jesser. (In French.) — When the driver gives a signal, for instance by means of an electric bell.

Mr. de Burlet. (In French.) — Then no opinion is expressed as to whether it is advisable to have one man on the locomotive or two?

Mr. du Beaufret. (In French.) — Allowances must be made for particular cases.

Mr. de Burlet. (In French.) — In France, is it permissible to have a single man?

Mr. C. Sapin. (In French.) — The decrees provide that one can have but a single man, but when one asks the departmental administrations that this rule should be applied, they raise objections which, moreover, are often well-founded, I admit. It happens, however, sometimes that the second man does not render those services which justify his presence.

Mr. de Burlet. (In French.) — But he is on the locomotive with the driver. In my opinion, this is necessary for the safety.

Mr. Jesser. (In German.) — We could

say in clause 2 : " It is recommended that the locomotive should be accessible from the carriages while running." (*Signs of approval.*)

Clause 3 mentions the shuttle service of trains on an English railway, in the following terms :

In the case of a shuttle service with a train of two carriages running on its own road-bed, the locomotive can be placed in the middle, if it is possible to operate at least the regulator and the brakes from the carriage-cabs at the ends of the train.

I may remark that I have added the word " brake ", although the English company does not mention this; but it is quite possible after all, that that is the case.

As regards clause 3, it should run : " In the case of a shuttle service with a train of two carriages running on its own road-bed." (*Signs of approval.*)

Mr. de Burlet. (In French.) — So be it, for those who go in for this odd practice!

The President. (In French.) — There there is agreement?

Mr. de Burlet. (In French.) — It is accordingly understood that section III is adopted with the different modifications proposed; in other words, there is agreement as to principles, while modifications have to be made in the text from the point of view of the drafting.

Order motion.

Mr. Georges Level. (In French.) — I have requested you to return to the question of the 40 metres (2 chains).

Mr. de Burlet. (In French.) — Mr. Level has in fact asked the bureau to return to the wording of clause 3 on page 56 of the report (1). We think we have already made great concessions, but are going to add to them. The original wording ran : " It is recommended as a rule not to have curves with a radius of less than 40 metres (2 chains) ". We proposed to say : " It is agreed to recommend that the line should be planned so as to have curves of as large a radius as possible. It is only in case of absolute necessity that one can go down to 40 metres (2 chains) ".

These gentlemen desire that the figure of 40 metres should not be given. Could we not adopt the following wording :

" It is agreed to recommend that the line should be planned so as to avoid curves of small radius. These should only be used in cases of absolute necessity. "

We have thus pushed conciliation to its extreme limits.

Mr. Jesser. (In French.) — Then the figure of 25 metres (1 $^1/_4$ chains) should be retained.

Mr. C. Sapin. (In French.) — One could say : " In the case of sharp curves, the vehicles require special equipment. "

Mr. Lembourg, National Suburban Railway Company, Belgium. (In French.) — Mr. Jesser asks that under these circumstances the radius of 25 metres (1 $^1/_4$ chains) should be reinserted in the table.

Mr. de Burlet. (In French.) — Do we agree? (*Signs of approval.*)

The President. (In French.) — Then that shall be so.

(1) See also *Bulletin of the Railway Congress*, 1910, July, p. 3172.

Mr. de Burlet. (In French.) — This is how we can word the conclusions which are to be submitted to the general meeting.

" The selection of the locomotive types for a narrow-gauge line very materially depends on the technical conditions of the line in question, particularly as regards curves and gradients, and the loads to be carried. The two elements (track and rolling stock) cannot, however, be considered separately and independently. It is from this point of view that the following recommendations are made :

" A) *Track* :

" 1° In all the cases, in which the selection of the gauge of a new line is not decided either by its immediate junction with another narrow-gauge system or by some other administrative considerations, a gauge of 1 metre (3 ft. 3 3/8 in.) is considered the best. Neither a smaller gauge than 600 millimetres (1 ft. 11 5/8 in.), nor a new gauge which does not yet exist, is to be recommended.

" 2° In the case of adhesion lines, it appears as a rule advisable not to have steeper gradients than 40 per mil.

" 3° The line should be planned so as to have curves of as large a radius as possible ; it should be decided to have no sharp curves unless this is absolutely necessary, and in such cases it is desirable that the vehicles should be specially equipped for the purpose. If the straights between the superelevation gradients of reverse curves are not equipped with guard rails, it is advisable that those straights should be at least as long as the greatest existing distance between the bogie centres of a vehicle.

" 4° If a busy traffic has to be dealt with, it will be advisable to build the road and roadbed to carry a load of 10 tons per axle (line with a gauge of 1 metre [3 ft. 3 3/8 in.]); this figure of 10 tons must, however, be increased in the case of lines having steep gradients and sharp curves.

" B) *Locomotives :*

" 1° In order to increase the power of the locomotives, the following may be recommended : a higher working pressure (up to 14 atmospheres), superheating the steam, compounding ; these three methods can be utilized either separately or simultaneously.

" 2° On lines with many curves, it is recommended not to have greater rigid wheelbases than shown in the table below :

MINIMUM RADIUS OF CURVES.	MAXIMUM RIGID WHEELBASE.
25 metres (1 1/4 chains).	1·4 metres (4 ft. 7 1/8 in.).
40 metres (2 chains).	1·8 metres (5 ft. 10 7/8 in.).
50 metres (2 1/2 chains).	2·0 metres (6 ft. 6 3/4 in.).
75 metres (3 3/4 chains).	2·5 metres (8 ft. 2 7/16 in.).
100 metres (5 chains).	2·9 metres (9 ft. 6 3/16 in.).
125 metres (6 1/4 chains).	3·3 metres (10 ft. 10 in.).
150 metres (7 1/2 chains).	3·6 metres (11 ft. 9 3/4 in.).
180 metres (9 chains).	3·9 metres (12 ft. 9 9/16 in.).

" If the adhesive weight necessary cannot be obtained inside the limits set by

these wheelbases and the admissible maximum axle-loads, then lateral play and not having flanges on some of the pairs of coupled wheels can be recommended; if these measures do not suffice, then they can be replaced either by having some of the coupled axles radially adjustable, or by using one or two motor bogies movable relatively to the main frame, with mechanical transmission of power from one main steam engine, or with a separate steam engine to each truck.

" C) *Metal cover for the moving parts :*

" If the locomotives are liable to suffer from an unusual amount of dust, it is possible to protect the moving parts by a covering, which should be as complete and as dust-proof as possible. Doors are to be provided in this covering so as to give easy access to the moving parts.

" D) *Foot-plate at each end of the locomotive :*

" 1° In the case of lines which pass through districts where there is much traffic, it is advisable that the driver should have a good view of the track in front of the locomotive.

" If it is not possible always to turn the locomotives so as to be head on, it is advisable either to have a cab at each end of the locomotive (from which the regulator and the cut-off can be operated, and the necessary signals given), or to equip the locomotive with a single raised cab, from which a view of the track can be obtained in each direction.

" 2° In the case of lines where the locomotive crew can consist of one man only, it is advisable that the locomotives should be accessible from the carriages while running ; this can be effected in the case of tank locomotives, by having two foot-plates with gangway connections, for giving access to the carriages. With such an arrangement, only one of the foot-plates need be equipped for driving.

" 3° In the case of a shuttle service with a train of two carriages running on its own roadbed, the locomotive can be placed between the two carriages (this eliminates all shunting operations at the termini) provided that it is possible to operate, from the platforms which in the case of each carriage form the end of the train, at least the regulator and the brake. "

— Adopted.

Mr. de Burlet. (In French.) — Gentlemen, before concluding the meeting, we have to thank the honourable reporter who undertook an exceedingly conscientious, detailed and laborious piece of work, which must have taken him a long time. We must be grateful to him for the documents he has collected, by which, with rare skill, he has enabled us to profit. His excellent work will occupy a place of honour in the libraries of all those who are occupied with the difficult question of the locomotives used on secondary railways. (*Applause.*)

DISCUSSION AT THE GENERAL MEETING

Meeting held on 14 July 1910 (afternoon).

Mr. P. WEISSENBACH, president, in the chair.

General secretary : Mr. L. WEISSENBRUCH.

First assistant general secretary : Mr. MÜRSET.

Second assistant general secretary : Dr. A. BONZON.

Mr. de Burlet, *vice-president of the 5th section*, read the

Report of the 5th section.

(See *Journal de la huitième session*, No. 8, p. 5.)

" Mr. Jesser (*reporter*) stated that the subject he had to deal with included both the locomotives and the rolling stock of narrow-gauge railways. But owing to the great extension of his work which had resulted from the abundance of information supplied to him by the different administrations, he had been compelled to limit his investigation to the first part of the subject, namely to locomotives, and to leave it to the Congress to deal with the second part at a future session.

" After a summary account of the principal elements which characterized the chief types of tractors described in his report, Mr. Jesser proceeded to show that each of these types corresponded to particular conditions of the line (plan and profile) and of the traffic. Whenever one had been compelled, by the topographical nature of the country, to have curves of small radius and steep gradients, it had also been necessary, in the case of traffic sufficiently developed, to adopt special devices for the locomotives, sometimes complicated and difficult to maintain (high pressure in the boiler, superheating, compounding, flexible axles, motor bogies). Mr. Jesser described and analysed the recent prescriptions (1908) of the German *Verein* on the subject of these different devices.

" The meeting then considered in succession the different conclusions given in Mr. Jesser's report. Several delegates, more especially Mr. C. Sapin (*Côtes-du-*

Nord Railway, France) and Mr. Chassin (*French Southern Railway*), stated that it would be very desirable, in drawing up schemes for narrow-gauge lines, if one paid greater attention to ease and facility of operation, and sacrified these elements less to considerations of economy in construction. They remarked that in France the State regulations did not concern themselves with the speed of trains on lines which did not use the public roads; any improvement in the plan of the line thus made it possible to improve the service from the point of view of the time required for the journey.

" Mr. Girtanner (*Swiss government*) informed the meeting that in Switzerland the regulations concerning narrow-gauge lines specified maximum speeds which differed according to whether the lines had a special roadbed or were laid on public roads, whether the rolling stock was equipped with the continuous brake or not, etc. In passing through towns, in the case of narrow streets, this maximum was reduced to 12 kilometres (7·5 miles) per hour.

" Different remarks were then exchanged, more especially on the subjects of superheating, of the advantages and disadvantages of a metal cover for the moving parts, and of two foot-plates for each locomotive. As for covers, Mr. Sapin remarked that the argument mentioned by the reporter, that horses and cattle would be frightened by the moving parts, no longer was of much importance, as motor cars were far greater offenders in this way than any trains on the public roads. As for foot-plates, the partisans of the single foot-plate chiefly invoked, in support of their opinion, the advantage of a continual supervision of the fireman by the driver who had to make certain that his assistant attended properly to the fire and to the feed, whereas the partisans of the double foot-plate attached most importance to the safety of the public when the trains passed through towns. Finally the section decided to submit the following conclusions to the general meeting."

The President. — The following are the

CONCLUSIONS.

" The selection of the locomotive types " for a narrow-gauge line very materially " depends on the technical conditions of " the line in question, particularly as " regards curves and gradients, and the " loads to be carried. The two elements " (track and rolling stock) can not how- " ever be considered separately and inde- " pendently. It is from this point of " view that the following recommenda- " tions are made :

" A) *Track :*

" 1° In all the cases, in which the " selection of the gauge of a new line is " not decided either by its immediate " junction with another narrow-gauge " system or by some other administrative " considerations, a gauge of 1 metre (3 ft. " 3 3/8 in.) is considered the best. Neither " a smaller gauge than 600 millimetres " (1 ft. 11 5/8 in.), nor a new gauge " which does not yet exist, is to be re- " commended.

" 2° In the case of adhesion lines, " it appears as a rule advisable not " to have steeper gradients than 40 per " mil.

" 3° The line should be planned so as " to have curves of as large a radius as " possible; it should be decided to have " no sharp curves unless this is absolutely " necessary, and in such cases it is desir- " able that the vehicles should be spe- " cially equipped for the purpose. If the " straights between the superelevation " gradients of reverse curves are not " equipped with guard rails, it is advis- " able that those straights should be at " least as long as the greatest existing " distance between the bogie centres of a " vehicle.

" 4° If a busy traffic has to be dealt " with, it will be advisable to build the " road and roadbed to carry a load of " 10 tons per axle (line with a gauge of " 1 metre [3 ft. 3 3/8 in.]); this figure of " 10 tons must however be increased in " the case of lines having steep gradients " and sharp curves.

" B) *Locomotives :*

" 1° In order to increase the power of " the locomotives, the following may be " recommended : a higher working press- " ure (up to 14 atmospheres), superheat- " ing the steam, compounding; these " three methods can be utilized either " separately or simultaneously.

" 2° On lines with many curves [and " having a gauge of 1 metre (3 ft. " 3 3/8 in.)] (1), it is recommended not to " have greater rigid wheelbases than " shown in the table below :

MINIMUM RADIUS OF CURVES.	MAXIMUM RIGID WHEELBASE.
25 metres (1 1/4 chains).	1·4 metres (4 ft. 7 1/8 in.).
40 — 2 .	1·8 — (5 ft. 10 7/8 in.).
50 — 2 1/2 .	2·0 — (6 ft. 6 3/4 in.).
75 — 3 3/4 .	2·5 — (8 ft. 2 7/16 in.).
100 — 5 .	2·9 — (9 ft. 6 3/16 in.).
125 — 6 1/4 — .	3·3 — (10 ft. 10 in.).
150 — 7 1/2 — .	3·6 — (11 ft. 9 3/4 in.).
180 — 9 .	3·9 — (12 ft. 9 9/10 in.).

" If the adhesive weight necessary can " not be obtained inside the limits set by " these wheelbases and the admissible " maximum axle-loads, then lateral play " and not having flanges on some of the " pairs of coupled wheels can be recom- " mended; if these measures do not " suffice, then they can be replaced either " by having some of the coupled axles " radially adjustable, or by using one or " two motor bogies movable relatively to " the main frame, with mechanical trans- " mission of power from one main steam " engine, or with a separate steam engine " to each truck.

" C) *Metal cover for the moving* " *parts :*

" If the locomotives are liable to suffer " from an unusual amount of dust, it is " possible to protect the moving parts by " a covering, which should be as complete " and as dust-proof as possible. Doors " are to be provided in this covering " so as to give easy access to the moving " parts.

(1) The words in brackets were added in the final reading (see below).

" D) *Foot-plate at each end of the locomotive :*

" 1° In the case of lines which pass through districts where there is much traffic, it is advisable that the driver should have a good view of the track in front of the locomotive.

" If it is not possible always to turn the locomotives so as to be head on, it is advisable either to have a cab at each end of the locomotive (from which the regulator and the cut-off can be operated, and the necessary signals given), or to equip the locomotive with a single raised cab, from which a view of the track can be obtained in each direction.

" 2° In the case of lines where the locomotive crew can consist of one man only, it is advisable that the locomotives should be accessible from the carriages while running; this can be effected in the case of tank locomotives by having two foot-plates with gangway connections, for giving access to the carriages. With such an arrangement only one of the foot-plates need be equipped for driving.

" 3° In the case of a shuttle service with a train of two carriages running on its own roadbed, the locomotive can be placed between the two carriages (this eliminates all shunting operations at the termini) provided that it is possible to operate, from the platforms which in the case of each carriage form the end of the train, at least the regulator and the brake."

Mr. Greppi, Italian State Railway. (In French.) — The section, in its conclusions, recommends that for given radii certain rigid wheelbases should not be exceeded, but it does not mention the gauge. I think that these wheelbases are calculated for the gauge of 1 metre (3 ft. $3\ ^3/_8$ in.), but it is perhaps advisable to say so.

Mr. de Burlet. (In French.) — They in fact do refer to a gauge of 1 metre (3 ft. $3\ ^3/_8$ in.), and if the meeting agrees, we will add these words to the conclusions.

— The conclusions of the 5th section, with these words added : " and having a gauge of 1 metre (3 ft. $3\ ^3/_8$ in.) ", are adopted.

APPENDIX

Corrigenda to report.

Page XIX-16 of the separate issue No. 66 and of the *Proceedings* (page 3132 of the *Bulletin* of 1910), column 2, line 4 from the top, *instead of :* " with one conception, between...", *read :* " with one exception (100 metres [5 chains]), between..."

Page XIX-26 (page 3142 of the *Bulletin*), figure 15, *instead of :* " Kinnekulle-Sidköpping-Häkantorp line ", *read :* " Kinnekulle-Lidköpping-Häkantorp line ".

Page XIX-26 (page 3142 of the *Bulletin*), figure 16, *instead of :* " Uddevalla-Lelaugen line ", *read :* " Uddevalla-Lelangen line ".

Page XIX-38 (page 3154 of the *Bulletin*), column 1, line 1 from the bottom, and column 2, line 17 from the bottom, *instead of :* " Swiss Federal Railway ", *read :* " Swedish State Railway ".

Page XIX-42 (page 3158 of the *Bulletin*), column 2, line 19 from the top, *instead of :* " to 1906 ", *read :* " to 1901 ".

Page XIX-44 (page 3160 of the *Bulletin*), column 2, line 2 from the top, *cut out the words :* " table 3 ".

Page XIX-44 (page 3160 of the *Bulletin*), column 2, line 8 from the bottom, *after the words :* " were built ", *add the following text :* " for a gauge of 1,000 millimetres (3 ft 3 3/8 in.) (item 4) ".

Page XIX-49 (page 3165 of the *Bulletin*), column 1, line 4 from the bottom, *instead of :* " in many cases ", *read :* " in all cases ".

Page XIX-51 (page 3167 of the *Bulletin*), column 1, line 6 from the top, *after the word :* " specified ", and column 2, line 4 from the top, *after the words :* " given above " *add the words :* " for carriages ".

Page XIX-55 (page 3171 of the *Bulletin*), column 2, lines 16 and 17 from the top, *instead of :* " the regulator can be operated ", *read :* " the regulator and whistle can be operated ".

Page XIX-58 (page 3174 of the *Bulletin*), column 1, question 1 *c*), and following pages, *instead of :* " reserve curves ", *read :* " reverse curves ".

Pages XIX-62, 64, 66, 68 and XIX-70 (pages 3178, 3180, 3182, 3184, 3186 and 3188 of the *Bulletin*), column 6, *instead of :* " Weight, in tons ", *read :* " Adhesive weight, in tons ".

Page XIX-67 (page 3183 of the *Bulletin*), last column, *instead of :* " the most powerful is given ", *read :* " the two most powerful are given ".

Page XIX-69 (page 3185 of the *Bulletin*), 1st column, line 3 from the top, *instead of :* " ∞ 10 ", *read :* " ∞ 6·5 ".

Page XIX-76 (page 3192 of the *Bulletin*), column 1, line 9 from the bottom, and following pages, *instead of :* " valve year ", *read :* " valve gear ".

Page XIX-78 (page 3194 of the *Bulletin*), column 2, lines 1 and 2 from the top, *instead of :* " 35 kilometres (21·7 chains) ", *read :* " 35 kilometres (21·7 miles) ".

Page XIX-79 (page 3195 of the *Bulletin*), column 2, line 13 from the bottom, *instead of :* " on the spen line ", *read :* " on the open line ".

Page XIX-80 (page 3196 of the *Bulletin*), column 2, line 6 from the bottom, *cut out the word :* " none ".

Page XIX-81 (page 3197 of the *Bulletin*), column 2, line 9 from the top, *instead of :* " Number 2 ", *read :* " Number : 4 ".

Page XIX-83 (page 3199 of the *Bulletin*), column 2, between the lines 4 and 5 from the bottom, *add the words :* " Steam heating : none ".

Page XIX-91 (page 3207 of the *Bulletin*), column 2, lines 13 and 14 from the top, page XIX-92 (page 3208 of the *Bulletin*), column 2, lines 10 and 11 from the top and 2 and 3 from the bottom, and page XIX-93 (page 3209 of the *Bulletin*), column 2, lines 2 and 3 from the bottom, *instead of :* " Nydquist & Hohn ", *read :* " Nydquist & Holm ".

Page XIX-92 (page 3208 of the *Bulletin*), column 1, line 1 from the bottom, *cut out the word :* " none ".

Page XIX-94 (page 3210 of the *Bulletin*), column 1, line 22 from the top, *instead of :* " Steam heating : none ", *read :* " Steam heating ".

Page XIX-97 (page 3213 of the *Bulletin*), column 2, line 4 from the top, *instead of :* " 2 ft. 11 1/2 in.", *read :* " 3 ft. 1 3/8 in.".

Page XIX-103 (page 3219 of the *Bulletin*), column 1, line 7 from the bottom, *instead of :* " Working compound in fourth ", *read :* " Working compound in four cylinders ".

SECTION V : LIGHT RAILWAYS

[625 .615]

QUESTION XX

TRANSHIPMENT

Examination of the different systems adopted for the exchange of goods between lines of different gauges (transhipment at the same level, sunk or raised tracks, trucks for taking cars of another gauge, tracks with three or four lines of rails, etc.).

Reporter :

All countries. — Mr. C. de Burlet, general inspector of bridges and roads, general manager of the Belgian national light railway Company, member of the Permanent Commission of the Congress.

QUESTION XX

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N. B. — See also the separate issue (in red cover) No. 20.

[625 .615]

REPORT

By C. DE BURLET,

GENERAL INSPECTOR OF BRIDGES AND ROADS,

GENERAL MANAGER OF THE BELGIAN NATIONAL LIGHT RAILWAY COMPANY.

The examination of the methods employed for the transhipment of goods between lines of different gauge has already been made an object of the deliberations of the Railway Congress, notably in its third Session at Paris, in 1889.

The discussion which then took place had reference chiefly to the following systems :

1° *Transhipment at the same level;*
2° *Sunk or raised tracks;*
3° *Movable truck-bodies;*
4° *Carrying-trucks* (for taking cars of another gauge).

Of these systems, the second was found to be costly in installation, and obstructive; as regards movable truck-bodies, the opinion was formed that, whilst these gave good results where the traffic was regular and important, they were not a success for traffic of a varying character and coming in both directions.

Carrying-trucks make it possible to convey main-line wagons upon narrow-gauge lines; their employment is suitable, it was thought, for goods liable to suffer from transhipment; but it could only be recommended as an exceptional thing on account of the inconveniences of the system; establishment of sunk transhipment tracks, not only in the stations, but also in the yards of the manufacturers linked up with the latter; considerable dead weight to carry, necessitating an extra charge and thus rendering onerous the generalization of the system among all classes of traffic; difficulty of braking, etc.

*

The Congress adopted the following resolutions :

1° Certain exceptional circumstances may justify, either from the point of view of the reduction of expense, or from that of the diminution of damage, the establishment of special transhipment arrangements, as for example, where the question is one of the working of mines, collieries, etc., connected by narrow-gauge lines with the main railroads, or in other similar circumstances;

2° But apart from these exceptional cases, it agrees in recommending, as a general rule, the simplest and most straightforward method of transhipment from truck to truck upon lines placed at the same level.

The very slightly enhanced cost at which the transfer of goods can be effected under such conditions renders very rarely justifiable the expense and inconvenience of special installations or the employment of exceptional arrangements : sunk or raised tracks, movable truck-bodies, carrying-trucks;

3° The only system which might, perhaps, be usefully employed, as being of a simple character and not involving much expense, is that of raising the narrow-gauge track in such a way that the floors of its trucks are at the same level as those of the standard-gauge line.

In certain cases, it might be possible to ameliorate in this way, at a trifling cost, the conditions of the transhipment of goods from the narrow-gauge to the standard-gauge line.

If there is a particular reason for doing so, on account of the importance of the goods brought to the standard-gauge line, it might even be advisable to raise the narrow-gauge line further by means of a platform.

Nevertheless, even as regards special installations of quite a modest character, it is advisable to weigh well the advantages and disadvantages before having recourse to them;

4° The experience of the last four years fully confirms the opinion expressed at the Brussels Session of the Congress, that " transhipment is in no way an obstacle to the development of subsidiary narrow-gauge lines, or to the great services they are capable of rendering.

The *Permanent International Union of Tramways* has also been induced to consider the question of transhipment, first at its general session of 1890, at Amsterdam, and more recently at that of London in 1902, with reference to the best *choice to be made in the gauge of light railways.*

Having been reporter on this question at the London session, the author of the present article arrived at the following conclusion, with which the general meeting concurred :

" If matters are regarded in a practical light, and not from a speculative and theoretical point of view, it must be recognized that *transhipment* can be effected with facility, without injury to the goods, and at little cost.

" Various methods and mechanical means have been devised with a view to rendering transhipment easier, but all are complicated and costly; and our experience, very widely established and confirmed by the opinion of many other companies, has satisfied us that, upon the whole, the simplest and most economical method is transhipment from truck to

truck, the floors of the two vehicles being brought, if possible, to the same level, which result may be achieved by raising the narrow-gauge line.

" The very slight cost (15 to 20 centimes per ton [1·46*d.* to 1·95*d.* per English ton]) at which the handling of the goods in the process of transhipment can be effected, justifies only very exceptionally the installation of the special arrangements alluded to above, such as sunk or raised tracks, movable truck-bodies, carrying-trucks, etc. "

Mention might also be made of an interesting article extracted from the *Zeitung des Vereins* and published in the *Bulletin du Congrès des chemins de fer* [1].

In this the various systems already referred to are described, the lines on which they are in operation being indicated, and the fact established that transhipment at a level is the system most universally adopted.

It will be seen by the preceding statements that the question now before us is not very new. Nevertheless, it is interesting to take the matter up again, with a view to discovering whether the conclusions arrived at by the Congress in 1889 hold good today. To this end we have drawn up the list of questions reproduced in the form of an annex at the end of the present report. We analyse, grouping them according to the various countries, the replies which have reached us :

I. — GERMANY.

The following administrations have replied to our list of questions :

1° Prussian State Railway (Directorates of Breslau, Elberfeld, Erfurt, Frankfort on the Main, Halle on the Saale, Stettin);
2° Alsace-Lorraine State Railway;
3° Bavarian State Railway;
4° Saxon State Railway;
5° Wurtemberg State Railway;
6° Munich Local Railway Company.

The various replies may be summed up as follows :

Prussian State Railway.

There exist in the districts enumerated above, 53 intallations for the exchange of goods between the standard-gauge system and narrow-gauge lines of varying measurements (0·60, 0·70, 0·75, 0·90 and 1 metre [1 ft. 11 $^5/_8$ in., 2 ft. 3 $^9/_{16}$ in., 2 ft. 5 $^1/_2$ in., 2 ft. 11 $^7/_{16}$ in., 3 ft. 3 $^3/_8$ in.]).

As regard two of these (Hohemlimburg and Plettemberg, in Westphalia), the

(1) See N° 5, May 1894, p. 359.

exchange is effected by means of carrying-trucks *exclusively*; the fifty-one others all employ the level method (eight among them concurrently with the employment of carrying-trucks). Under the heading of " transhipment at a level " we include not only arrangements by which the tracks are at the same level, but those by which the floors of the trucks are brought to the same level by a slight elevation of the narrow-gauge line-relatively to the standard-gauge line.

Seventeen of these exchange stations have, in addition, a raised-track arrangement, and in eight of such cases transhipment is further facilitated by the fact that the wagons of the narrow-gauge line have truck-bodies which swing over, or have a hopper bottom or one with a shelving ridge.

Figures 1 and 2 show : 1° cross-section of the raised track at Abendstern, where the narrow-gauge track transfers annually to the ordinary line by means of tip-wagons about 50,000 tons of mineral ore and limestone; 2° the cross-section of the arrangement at Kerkerbach, whereby the narrow-gauge track is laid upon a small bridge at right angles to the ordinary line. The floors of the trucks of the narrow-gauge line are made with a shelving ridge at the bottom.

These raised-track arrangements are met with most frequently at stations where there is an important exchange of goods little liable to damage (such as sand, mineral ore, gravel, beet, potatoes, etc.). The objection raised, however, against such arrangements is that they have the drawback of being fatal to the preservation of the floors of the trucks on the lower line, when the transhipped goods are too heavy or sharp-edged (ashlar, paving-stone, rock ore, etc.).

Further, it is found that the cost of maintenance of tip-wagons and those with a hopper-bottom is of an onerous character.

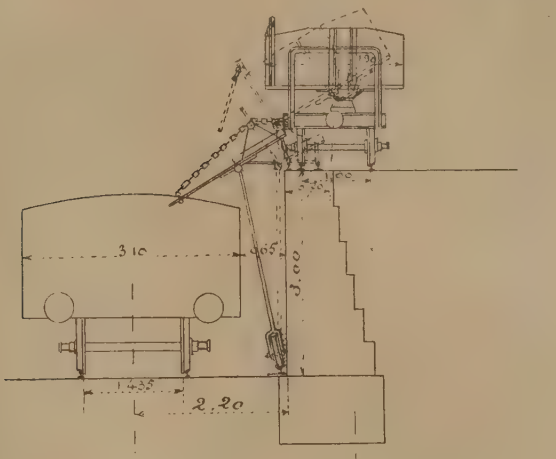
The cost of transhipment, which is from 2·50 to 3·25 francs (2*s.* to 2*s.* 7 $^1/_2$ *d.*) per 10-ton wagon where the level system is employed (25 to 40 per cent more for goods requiring a certain amount of arrangement, such as bricks, briquettes, etc.), descends to 1·50 or 2 francs (1*s.* 2 $^1/_2$ *d.* to 1*s.* 7 $^1/_2$ *d.*) under the raised-track system, and to 1 franc (10*d.*), or even less, if the narrow-gauge line trucks are of the tip type or have a hopper bottom or one with a shelving ridge.

Among the fifty-one exchange stations mentioned above, eight are served concurrently by the level method and by that of carrying-trucks (Langbein system). We give (figs. 3 to 7) plans of the carrying-trucks and of a sunk stowage track. (For a more detailed description of these contrivances we must, in order to avoid making the present report too long, refer the reader to the May 1894 number of the *Bulletin du Congrès des chemins de fer*, and to the *Annales des ponts et chaussées de France*, for the years 1894 and 1899.)

The Prussian State Railway considers that apparatus of this kind renders valuable service in preventing the necessity for the transhipment of specially fragile goods such as tiles, pottery, glass-ware, etc., but that their employment is not always possible (notably in the case of wagons with three axles); furthermore, they cannot, without some inconvenience, be intercalated in passenger trains; their use, therefore,

is chiefly to be recommended when the question is one of serving certain special manufactories linked up with the narrow-gauge line at points not very far distant from the junction station with the standard-gauge line.

Fig. 1. — Cross-section of the raised track at Abendstern.



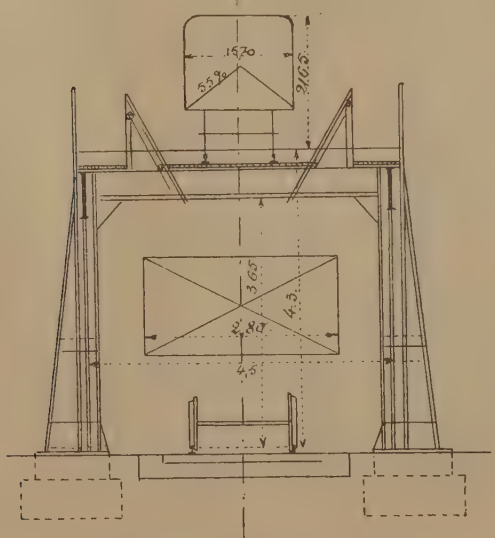
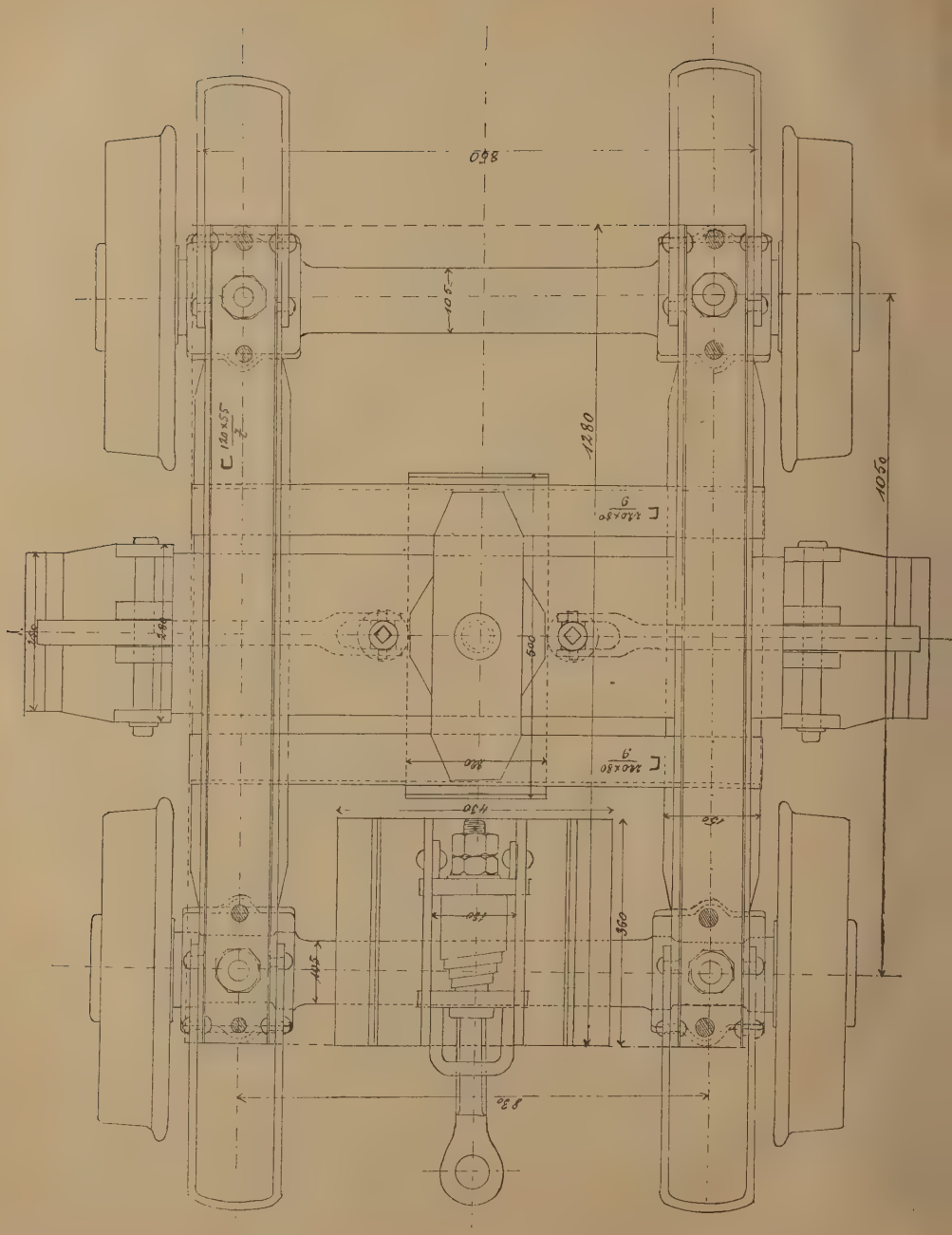


Fig. 2. — Cross-section of the arrangement at Kerkerbach.


850
105
1280
1050
C 140×55/7
C 240×80/9
C 240×80/9
600
440
164
130
130
150
360
230
830

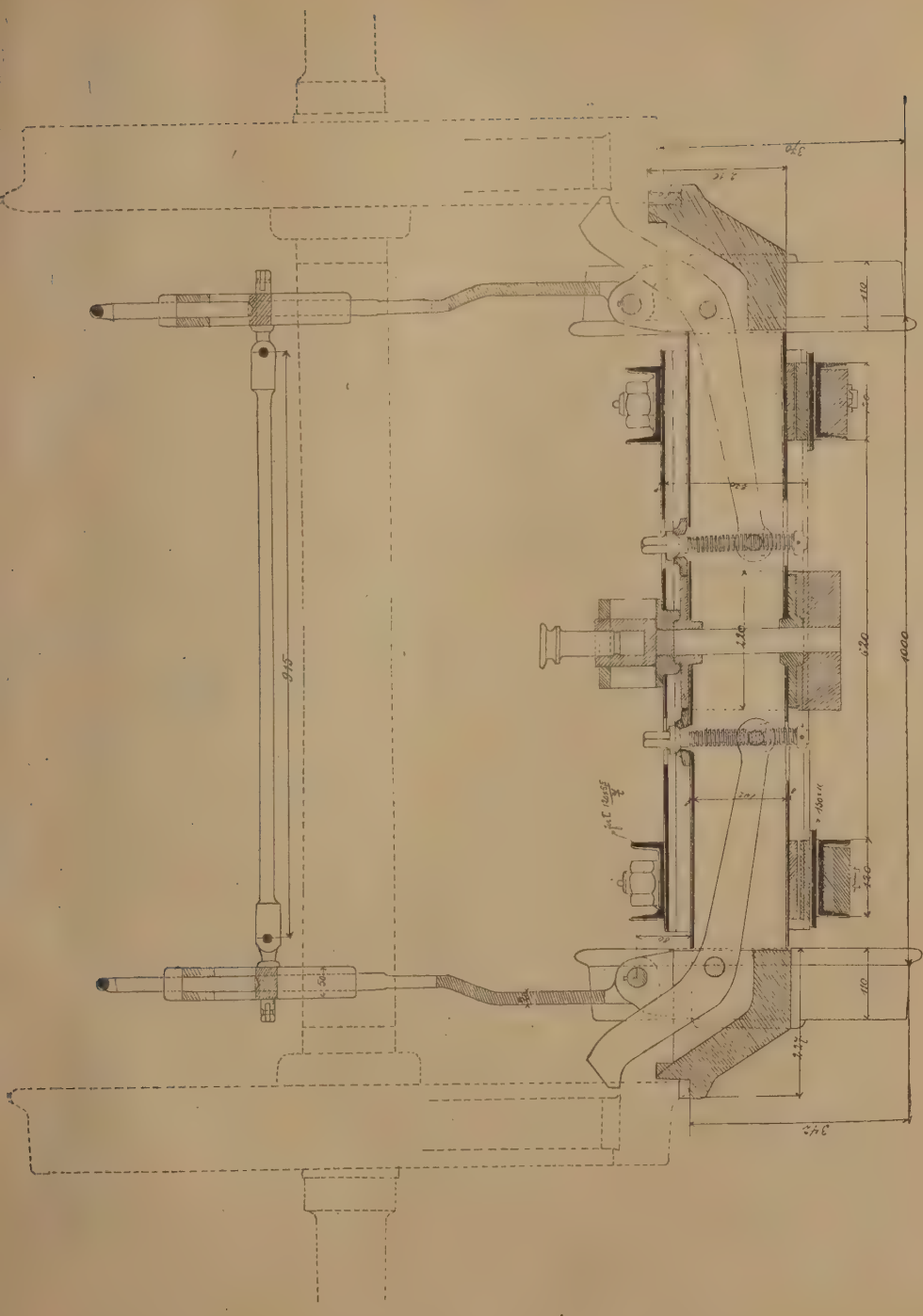


Fig. 4. — Cross-section of a carrying-truck.

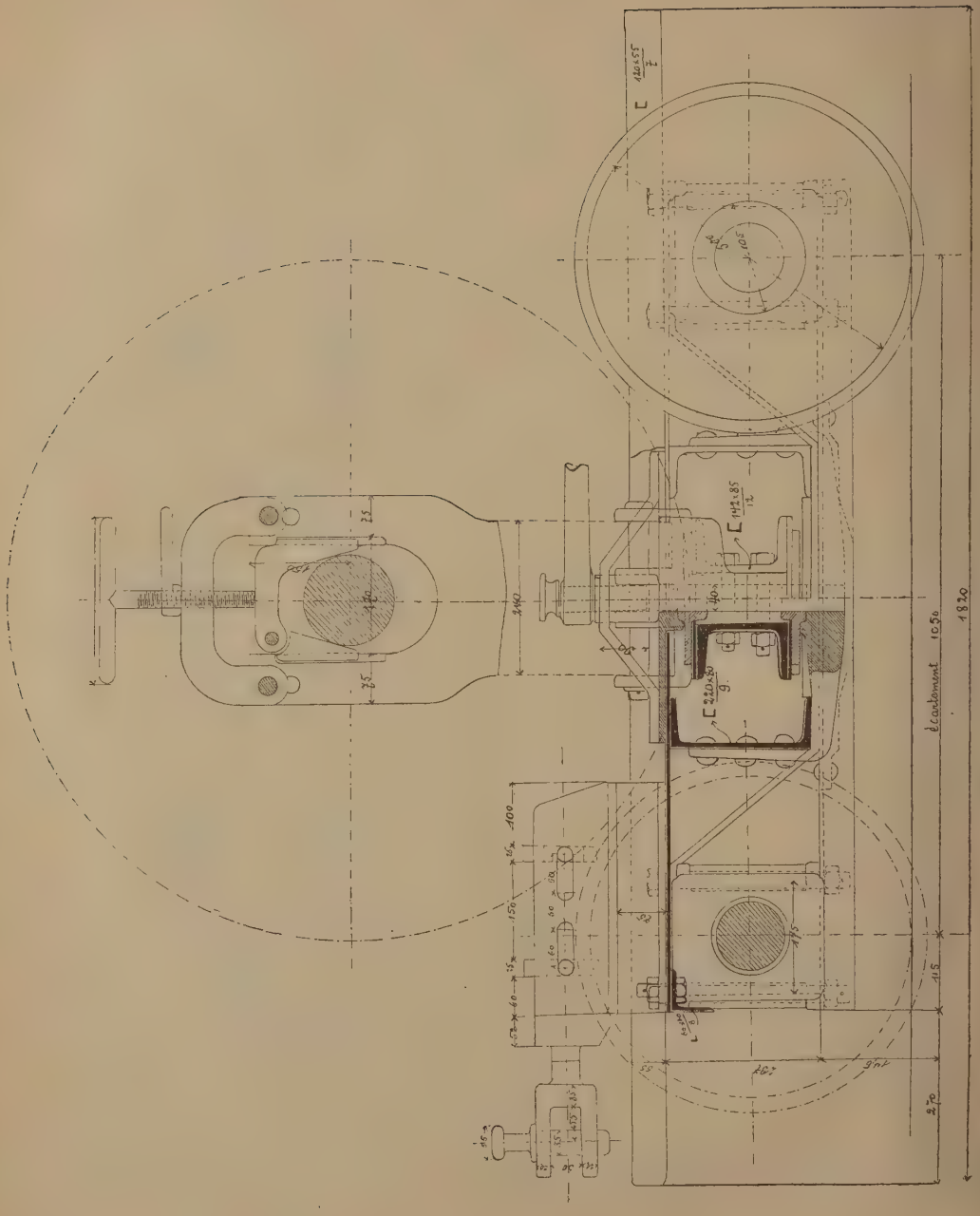


Fig. 5. — Longitudinal section of a carrying-truck.

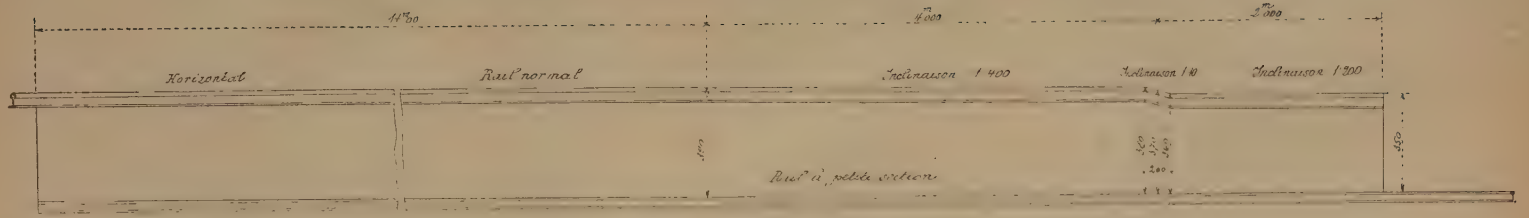


Fig. 6. — Longitudinal section.

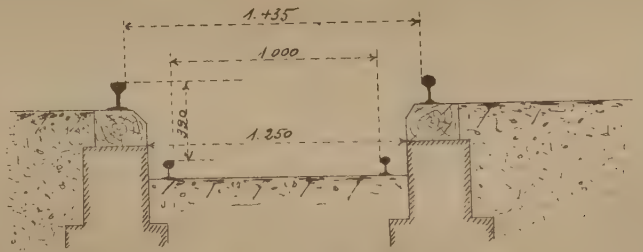


Fig. 7. — Cross-section.

Figs. 6 and 7. — Sunk stowage track.

Explanation of French terms : Horizontal = Horizontal. — Rail normal = Standard rail. — Inclinaison = Gradient. — Rail à petite section = Rail of small cross-section

The Prussian State Railway mentions, finally, that in four cases the narrow-gauge line has been equipped (over a short length of track) with a supplementary rail enabling certain special establishments to be served without transhipment. In particular, at Kerkerbach Station, there abuts a track with three rails, 3,700 metres (2·17 miles) in length, serving lime-kilns which dispatch and receive about 50,000 tons yearly. The extra expense due to this third rail may be estimated at 37,500 francs per kilometre (£2,414 per mile). Objection is raised to this arrangement, on the one hand because of the complication in the switches, and on the other because it involves the necessity for inserting a special truck (with triple buffing-gear) between the locomotive of the narrow-gauge line and the standard-gauge trucks.

Alsace-Lorraine State Railway.

Besides the exchange station at Luxemburg, to which reference is made farther on (see the heading " Grand-Duchy of Luxemburg "), the administration of the Alsace-Lorraine State Railway possesses three other installations for exchange with narrow-gauge lines.

These installations only admit of the level arrangement.

At Colmar, the iron road between the station and the port is fitted with three rails, access to the quays being thus permitted to vehicles of both gauges.

Bavarian State Railway.

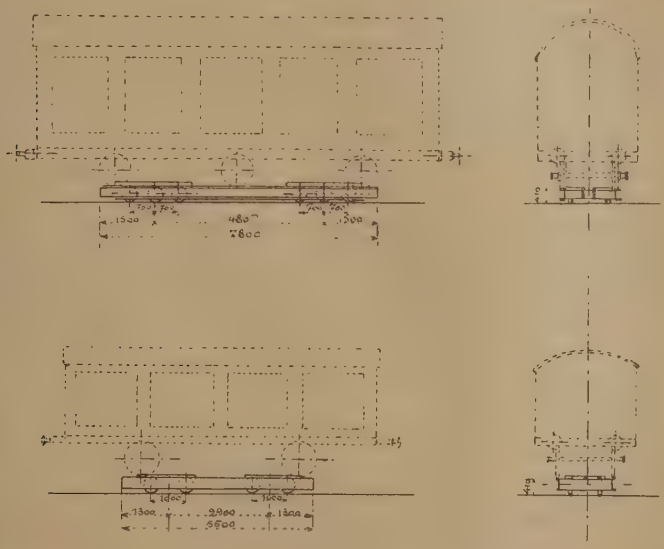
The exchange of goods at the Eischstätt-Kinding station is effected by crane so far as round timber is concerned, and by carrying-trucks, of the Langbein type, in the case of other goods; in the case of the latter, transhipment from truck to truck is exceptional (as for example, when the standard-gauge wagons have three axles, and consequently cannot be loaded upon trucks); it is effected, in such an event, by means of a transhipment platform extending from the goods-warehouse of the station.

For the round timber which constitutes the principal article of exchange (18,000 tons per annum), use is made of a travelling crane above a line with four rails; the narrow-gauge truck is first brought, loaded with wood, under the crane; the load is raised, and then the truck is withdrawn and replaced by a standard-gauge one, upon which the load is lowered.

With regard to the carrying-trucks, these have been in use since 1887 without ever having given rise to inconvenience; their employment, however, renders it necessary that the speed of the trains in which they are intercalated shall not exceed 15 kilometres (9.3 miles) per hour.

Saxon State Railway.

Twenty-five stations on this system exchange goods with narrow-gauge lines. They all include transhipment at a level; in every case, also, use is made either of carrying-trucks, or carrying-wagons. These carrying-wagons are composed of a floor supported on two bogies (of two or three axles each) and furnished with two rails 1·435 metres (4 ft. 8 $^1/_2$ in.) apart (figs. 8 to 11). The standard-gauge trucks are brought up along a loading ramp, furnished with a standard-gauge line on a level with and in extension of that of the carrying-wagon.



Figs. 8 to 11. — Carrying-trucks of the Saxon State Railway.

The Saxon State Railway prefers the carrying-wagons to the carrying-trucks, on the ground that they appear to present more security and to be more easily managed. It is necessary to state, however, that the dead weight of these carrying-wagons exceeds by at least 26 to 30 per cent that of the carrying-trucks. Unlike the trucks, they can receive three-axled standard-gauge wagons.

As to the cost of transhipment at a level, this naturally varies according to the class of goods dealt with. It gets as low as, roughly speaking, 2 francs (1*s.* 7 $^1/_2$*d.*) per 10-ton wagon for goods in sacks, and rises to about 3·50 francs (2*s.* 10*d.*) in the case of less easily-handled goods.

Wurtemberg State Railway.

This system includes six stations of exchange with narrow-gauge lines (gauges 0·75 and 1 metre [2 ft. 5 1/2 in. and 3 ft. 3 3/8 in.]). In these six stations the method of transhipment is that of at the same level, and is supplemented by travelling cranes (principally for the purpose of dealing with timber). In the case of all fragile goods use is made, at the six stations referred to, of carrying-trucks.

Munich Local Railway Company.

This company has sent us a note giving very interesting details regarding its operation of the Urban Tramways of Forst (Brandenburg). These tramways have a 1-metre (3 ft. 3 3/8 in.) gauge; seventy-seven manufactories are linked up with them. The goods traffic (in the two directions) reaches a total of about 23,000 trucks of 10 tons each per annum; the greater part of this traffic (*i. e.* about 19,000 trucks) consists of coal brought by the standard-gauge line to Forst Station and there taken up by the tramway for distribution among the associated manufactories.

All this traffic between Forst-Station and Forst-Town is carried on exclusively by means of carrying-trucks (there are 98 in use). The three sunk stowage tracks installed at Forst Station are regulated so that each can receive at once ten pairs of trucks; the main line can therefore bring or retake at one time 30 trucks of standard-gauge.

In ordinary working 60 to 80 large loaded trucks pass daily from one line to the other, and as many empty trucks.

The coupling of the carrying-trucks with each other and with the locomotive of the narrow-gauge line is effected by means of bars of about 3 metres (10 feet) in length; each vehicle thus preserves the play necessary for its passage round curves the radius of which may not exceed 15 metres (3/4 chain).

This use of carrying-trucks for the purpose of establishing a sort of urban iron-road drayage is evidently most advantageous to the local industries; in addition, it greatly facilitates the service of the main-line station, and frees the municipal authority from the comsiderable expense which would be necessitated for repairs to its highways if the 230,000 tons carried annually by the Langbein trucks had to be conveyed by cart.

II. — ARGENTINE REPUBLIC.

The Buenos Ayres-Rosario-Argentine Central Railway (gauge 1·676 metre [5 ft. 6 in.]) possesses seven stations of exchange with various lines of a narrower gauge (0·75, 1 and 1·435 metre [2 ft. 5 1/2 in., 3 ft. 3 3/8 in., 4 ft. 8 1/2 in.]). In the case

of all these stations there is no transhipment arrangement other than that at a level.

III. — AUSTRIA-HUNGARY.

Austrian State Railway.

On the Austrian State Railway there are eighteen stations of exchange with narrow-gauge lines. All these stations are established in conformity with the level system; one of them possesses in addition, a raised-track arrangement. In the case of four others, certain exchanges are effected by means of carrying-trucks.

Hungarian State Railway.

The Hungarian State Railway possesses fifteen stations where goods are exchanged with narrow-gauge lines. These fifteen installations all possess an arrangement for transhipment at a level. Four among them have, in addition, a raised-track, and two others a sunk-track, system. One installation alone makes use of carrying-trucks.

Austrian North-Western Railway (and German South-North Junction).

Upon this railway there are two exchange installations. In one (Reichenau) where the traffic, to a greatly-preponderating extent, is from the standard-gauge to the narrow-gauge line (37,000 tons in the one direction and less than 1,000 tons in the other), there is, in addition to the level system, a sunk-track arrangement (see cross-section, fig. 12). In the other station (Friedland), which serves, at the point

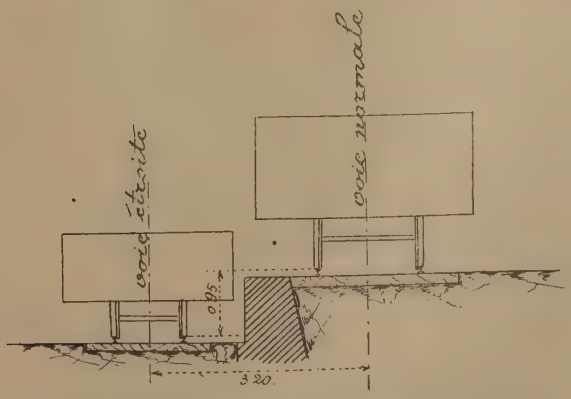


Fig. 12. — Sunk-track arrangement.

Explanation of the French terms : Voie étroite = Narrow-gauge line. — Voie normale = Standard-gauge line.

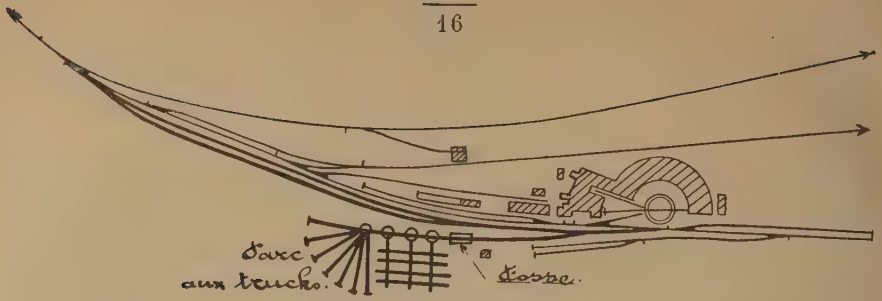


Fig. 13. — General plan.

Explanation of French terms : Parc aux trucks = Truck-yard. — Fosse = Sunk tracks.

Figs. 14 to 18. — Ramsey sunk track.

Fig. 14. — Longitudinal section.

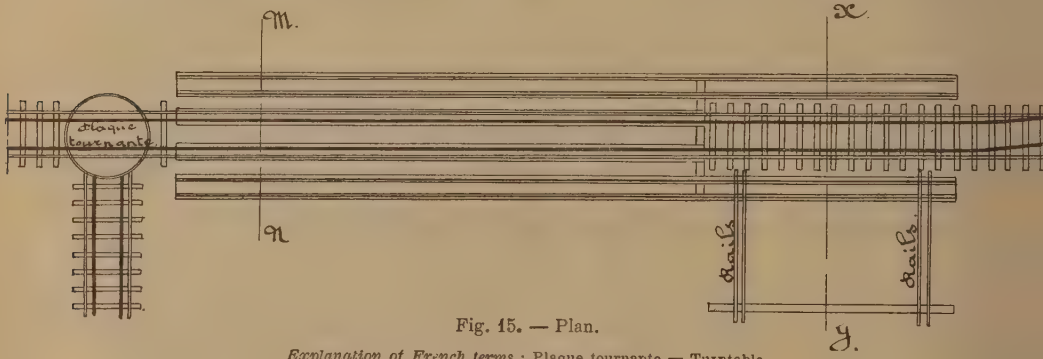


Fig. 15. — Plan.

Explanation of French terms : Plaque tournante = Turntable.

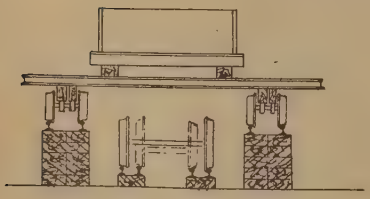


Fig. 16. — Section *mn*.

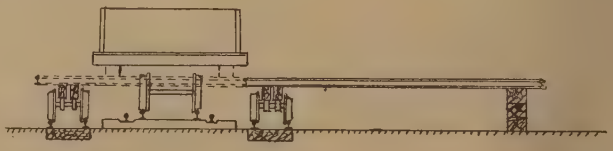


Fig. 17. — Section *xy*.

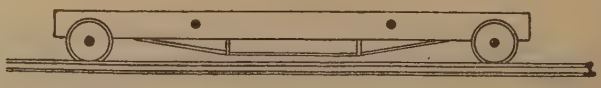


Fig. 18. — Elevation of a truck.

of departure of the narrow-gauge line, a rather considerable traffic in pottery and manufactured articles, use is made of carrying-trucks concurrently with the level system.

IV. — BELGIUM.

The narrow-gauge system of Belgium (3,350 kilometres [2,082 miles] in operation on 30 June 1909) possesses a hundred and forty-five points of exchange with lines of the standard-gauge. All these exchange stations have the level arrangement; in the case of one only of them, the Langbein carrying-trucks are also used (principally for the conveyance of sulphuric acid in tank-trucks) and, in one other carrying-wagons (chiefly for the transport of certain exceptionally friable kinds of coal). The goods utilizing these special contrivances reach, however, only a very limited tonnage.

No example of either sunk or raised tracks can be met in the exchange stations mentioned above; but the plan of fitting with four rails a few sections of narrow-gauge line has met with a certain amount of favour. Six separate sections, measuring altogether about 40 kilometres (25 miles), have been equipped in this way (three among them serving quarries, two others ceramic-produce factories, and the last a coal-mine).

The arrangement with four rails is preferred to that with three, as it avoids all eccentric action in the haulage of standard-gauge trucks by narrow-gauge locomotives. This haulage is effected, either by means of an intermediate truck fitted with a double coupling, or by equipping the locomotive itself with this double coupling.

In the opinion of the Belgian National Light Railway Company, the equipment of the line with four rails constitutes (principally from the point of view of facility in working) an excellent solution of the problem of serving without transhipment manufactories with a large traffic; but this solution is costly (an increase of at least 25,000 to 30,000 francs [£1,609 to £1,930] per kilometre for the regular line and of 3,500 francs [£140] for each switch); it is not, therefore, to be recommended unless the sections to be so equipped are short.

We give (figs. 19 to 23) a few sketches showing the arrangements adopted for the switches of these lines with four rails; these switches clearly constitute the most delicate appliance in the installation.

As regards transhipment at a level, this is effected in Belgium under conditions similar to those of neighbouring countries; it is generally carried out by the management of the narrow-gauge line at the regulation price of 25 centimes (2·44*d.*) per ton (40 or 50 centimes [3·90*d.* or 4·88*d.* per English ton] for timber. At the same time, consignors are allowed the latitude of adopting their own methods of procedure, and they not infrequently avail themselves of such latitude where there is a question of regular and important traffic, as by so doing it is possible to realize a saving of from 20 to 30 per cent in the regulation price.

Figs. 19 to 23. — Special switches for tracks with four rails. Gauges of 1 metre and 1.435 metres (3 ft. 3 $^{3}/_{8}$ in. and 4 ft. 8 $^{1}/_{2}$ in.).

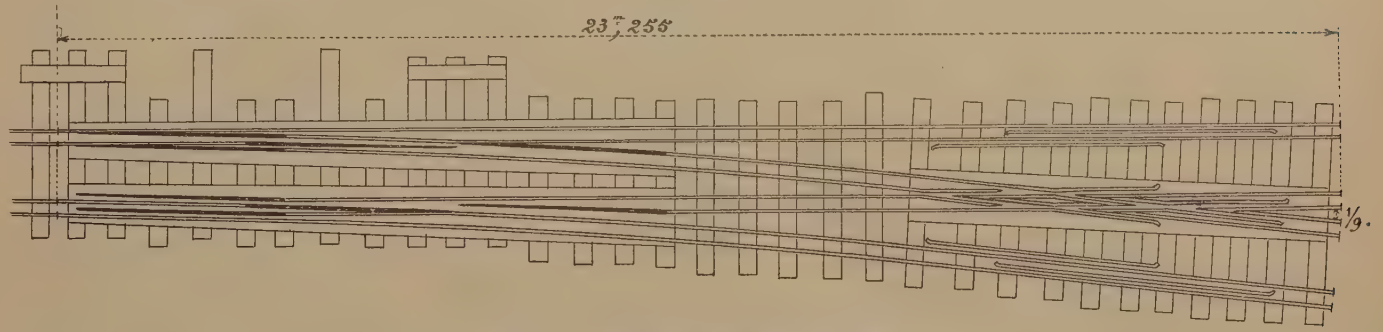


Fig. 19. — Switch for a track with four rails.

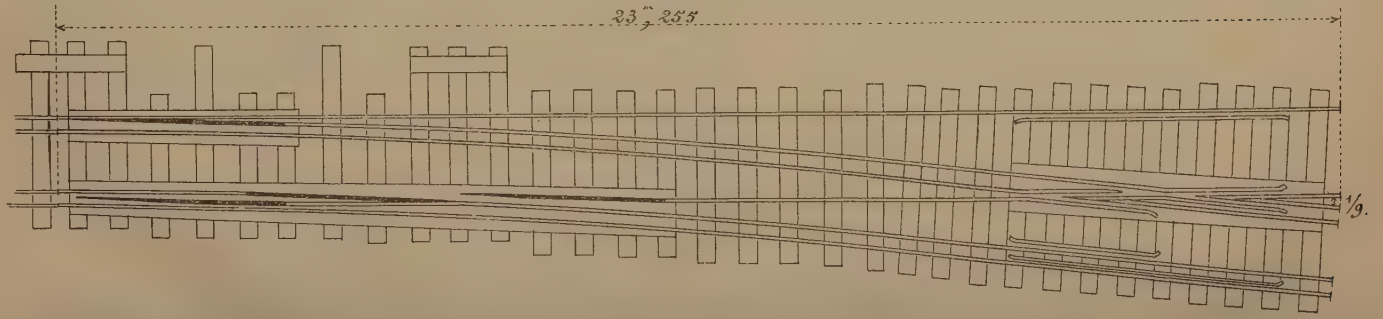


Fig. 20. — Switch connecting a track with four rails to a standard-gauge track.

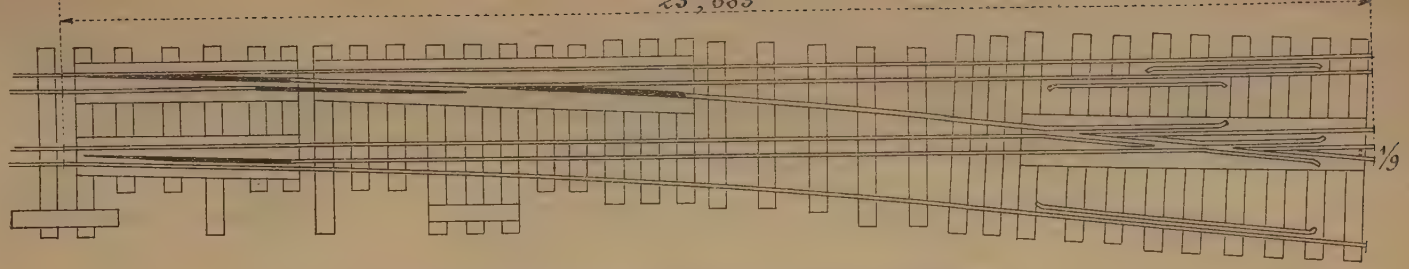


Fig. 21. — Switch connecting a standard-gauge track with a four-rail track.

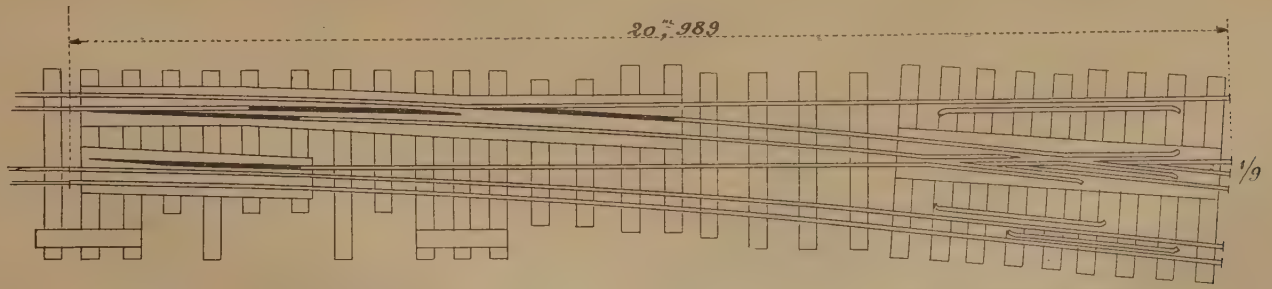
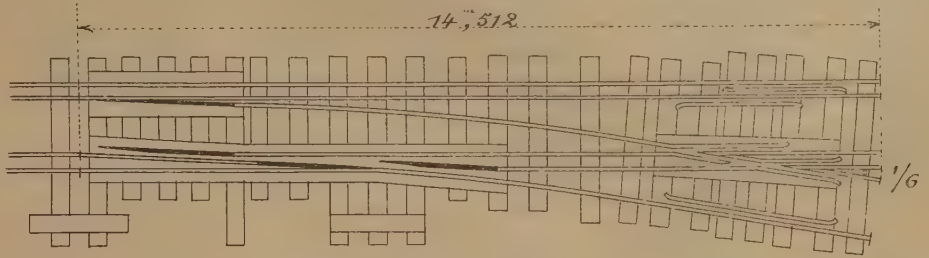


Fig. 22. — Switch connecting a four-rail track with a track of 1 metre (3 ft. 3 3/8 in.) gauge.



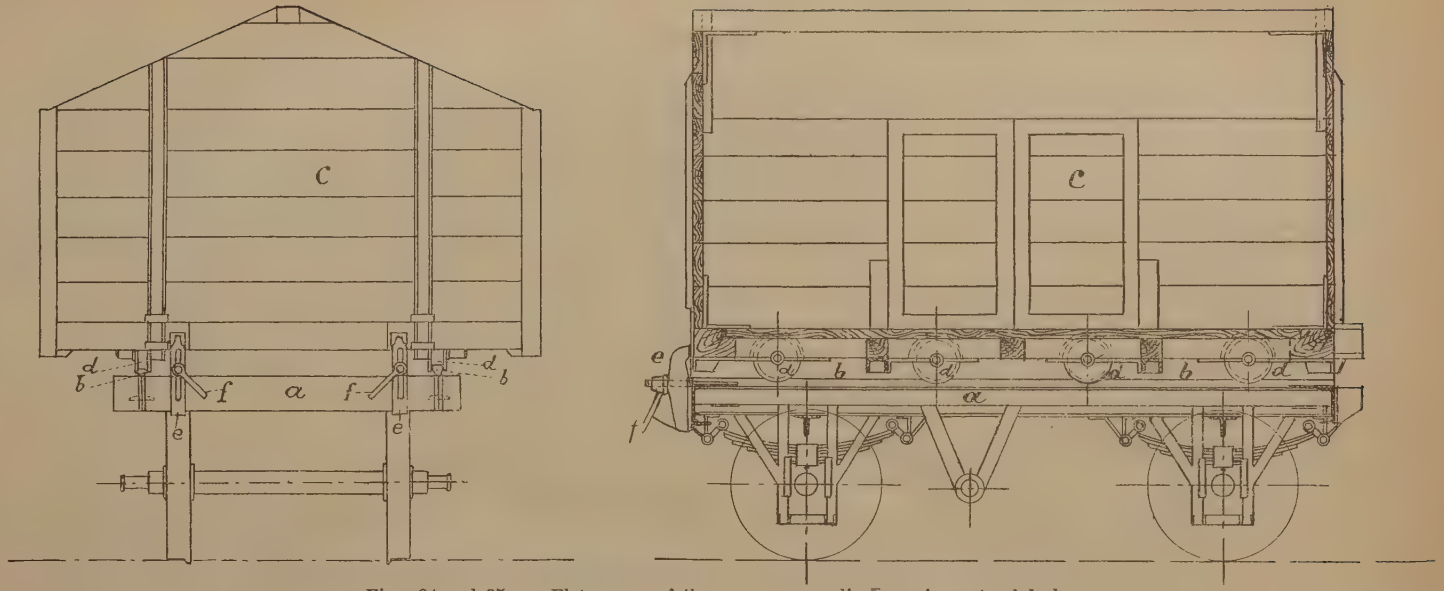
EXPLANATION :

Rails or check-rails (fixed).

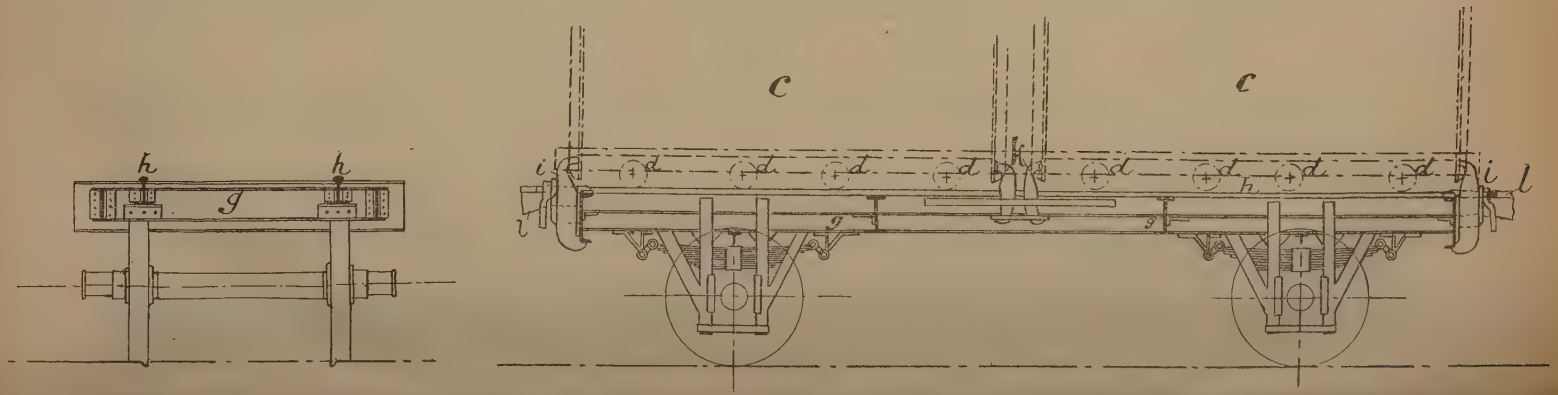
Movable portions.

N. B. — In each case all the movable portions are worked with a single lever.

Fig. 23. — Switch connecting a track of 1 metre (3 ft. 3 3/8 in.) gauge with a four-rail track.



Figs. 24 and 25. — Flat wagon of the narrow-gauge line carrying a truck-body.



Figs. 26 and 27. — Flat wagon of the standard gauge line carrying two truck-bodies.

V. — DENMARK.

Danish State Railway.

Three narrow-gauge lines are linked up with the Danish State Railway. The transhipment arrangement adopted at the junction-stations is that on a level. An interesting point arises, however, in connexion with the narrow-gauge track from Kolding to Egtved. This line has had constructed special flat trucks of the two gauges (twenty-four for the narrow-gauge line and six for the standard); the floors of these flat trucks are provided with two lines of rail designed to receive movable truck-bodies mounted upon wheels 0·16 metre (6 $^{5}/_{16}$ miles) in diameter (see figs. 24 to 27). In the exchange station there has been constructed a standard-gauge line prolonged from one of the narrow-gauge lines (the centre lines of the two tracks are thus in a straight line), the standard-gauge track being 0·40 metre (1 ft. 3 $^{3}/_{4}$ in.) lower than the narrow-gauge line. As the rails upon the floors of the flat trucks of the ordinary-gauge line are 1·23 metre 4 ft. $^{7}/_{16}$ in.. above the rails of the latter, whilst the corresponding figure is only 0·83 metre (2 ft. 8 $^{11}/_{16}$ in.) for the flat trucks of the narrow-gauge line, it is obvious that, if one brings upon the latter a train of flat trucks furnished with their movable truck-bodies, and if ends of loose rails are placed between the successive trucks in order to secure the continuity of the path over the raised surfaces, it is possible, by a simple working of the chain, to make the series of movable truck-bodies (attached together) pass from the flat trucks of the narrow-gauge line on to the train of flat trucks of the standard-gauge line.

Each truck-body is capable of holding 5 tons; the line possesses fifty-four open ones and six closed. Their chief service is to carry the traffic between the narrow-gauge line (which serves important sugar-works) and the port of Kolding, which possesses only standard-gauge tracks. They are of further assistance in conveying to the main line-stations — as far, even, as Berlin itself — delicate commodities that will not stand transhipment (cauliflowers, for example).

VI. — EGYPT.

The Egyptian State Railway has twelve stations of exchange with lines of narrow-gauge not worked by itself, and a thirteenth with a narrow-gauge line forming part of its own system. The level arrangement is adopted in the case of all these points of exchange. It gives satisfaction to the administrations concerned and to the public.

VII. — SPAIN.

The only particulars which have reached us have been furnished by the Spanish Northern Railway Company, which operates twelve stations of exchange with lines

of a gauge different from its own. In the case of all these stations the level system is adopted. Nevertheless, at the station of La Robla, where the narrow-gauge line from La Robla to Valmaseda joins, which brings to the main line an important coal traffic (40,000 tons annually), the transhipment of these goods is effected by the raised-track system.

The company is of opinion that, despite all the care exercised in the work of transhipment, some damage is inevitable, principally in the case of goods of a delicate nature such as fruit; and in certain cases consignors are induced to make use of a longer route in order to avoid the necessity for transhipment.

VIII. — UNITED STATES OF AMERICA.

Lines of a gauge other than the standard are very rare in the United States; therefore the majority of the railway companies which have replied to us state that they do not possess transhipment stations.

The Pennsylvania Railroad has two of them (traffic of but little importance) where the exchange of the goods is effected by the level method.

The Boston & Maine Railroad possesses at the station of Hoosac Tunnel an exchange station for the service of the narrow-gauge line which joins it there (Hoosac Tunnel & Wilmington Railroad). Transhipment is there, also, effected by the level system, the two lines of exchange being separated by a raised stage (transhipment stage) of timber-work, about 3 metres (10 feet) in breadth, set on a level with the floors of the trucks. The principal object of this transhipment stage is to permit loading and storing of goods, even when the trucks (of the other gauge) which ought to receive them have not arrived. The exchange traffic amounts to about 8,000 tons per month; the cost of transhipment is about 50 centimes (4·88*d.* per English ton) per ton.

The Baltimore & Ohio Railroad has sent us an interesting note on the subject of the exchange station at Fixburg (Pennsylvania). This station possesses an arrangement for transhipment at a level similar to those of the European companies. About 10,000 tons are handled there monthly, at the cost of about 50 to 60 centimes (4·88*d.* to 5·85*d.* per English ton) per ton (wages of transhipment employees: 90 centimes [9*d.*] per hour).

If, in the case of certain goods, it is desirable to avoid transhipment from truck to truck, use is made of the " Ramsey " sunk track (see figs. 13 to 18) which enables the bodies of standard-gauge cars to be placed on narrow-gauge trucks, and vice-versa (it is well known that in the United Stetes the majority of the cars are on bogies). To this end, the sunk track (fitted with four rails) has on each side a track with a gauge of about 0·50 metre (1 ft. 7 $^{11}/_{16}$ in.), on which small carrier-wagons can travel. By means of transverse rails resting upon these small wagons and of sleeper blocks, the body of the trucks can be supported upon the said carrier-wagons; by a movement of the whole system above the sunk track, a separation is

effected between the truck-body and the bogies of standard-gauge; these bogies are shunted by means of the turn-table indicated in the sketch, and those of the narrow-gauge are brought up with a view to the reverse operation.

The cost of a Ramsey sunk track is about 10,000 francs (£400), and the substitution of the trucks as described above involves in respect of manual labour an outlay of about 2·75 francs (2*s*. 2 1/2 *d*.) per truck, that is to say 20 to 25 centimes per ton (1·95*d*. to 2·44*d*. per English ton); the trucks utilizing the Ramsey sunk track are chiefly of 12 tons or less.

IX. — FRANCE.

French Eastern Railway.

Up to the present time there does not exist in the stations at which lines of narrow-gauge terminate any arrangement for transhipment other than at the same level. The traffic exchanged is of small importance; the net cost of transhipment is at least 30 centimes per ton (2·93*d*. per English ton).

Carrying-trucks ran for some time on a narrow-gauge line in the Ardennes; but the company working this line no longer uses them.

French State Railway.

Exchanges with narrow-gauge lines are effected by transhipment at a level. The work is usually entrusted to piece-workers; the price paid to them for it varies according to the stations and amounts on an average to 21 centimes per ton (2·05*d*. per English ton).

Nothing has occurred to suggest that the desire to avoid transhipment has taken away from narrow-gauge lines any class of traffic.

As the station of Melle (Deux-Sèvres), carrying-trucks of the Langbein type are used in order to secure the traffic of the distillery of Mardre upon the line (of 1 metre [3 ft. 3 3/8 in.] gauge) from Sainte-Maixent to Melle. This manufactory, situated 3,500 metres (2·2 miles) from the junction-station, receives and dispatches on an average 35 trucks of alcohol daily during the active period of its traffic (October to February). The carriage is effected by special trains, each train comprising at most two loaded trucks of 10 tons or three empty trucks. The cost of the carriage is 70 centimes per ton (6·83*d*. per English ton), all expenses of management included.

French Midi Railway.

The arrangement generally adopted on this system is, as in the two preceding cases, transhipment on a level. Nevertheless, at Cerbère (international station of exchange with the Spanish system), there exists a Spanish line raised 1·03 metres

(3 ft. 4 $^{9}/_{16}$ in.) as compared with the French line; it is by means of these two tracks that the transhipment of mineral ore brought from Spain is effected.

A similar arrangement is contemplated for the exchange station of Villefranche-Vernet-les-Bains, with a view to facilitating the transhipment of mineral ore brought by the new narrow-gauge line from Villefranche to Bourg-Madame.

The cost of transhipment at a level varies from 20 to 50 centimes per ton (1 95 to 4·88*d.* per English ton), according to locality and nature of the goods. As regards transhipment by the raised track at Cerbère, this is carried out under the supervision of the forwarding agents, and the Midi company does not indicate its cost.

French Northern Railway.

The transhipment arrangements invariably include the level system, and frequently sunk and raised tracks. We reproduce by way of specimen a plan of the station of exchange at Doullens (fig. 28), where are transhipped annually about 10,000 tons of goods brought by the main line, and 14,000 tons brought by the narrow-gauge line.

This plan shows that the sunk and raised track methods can be utilized without meriting to any serious extent the charge of obstruction levelled at them at the 1889 Session. We give also (figs. 29 to 32) standard sections of the various transhipment arrangements of the Northern Railway.

The company thus expresses itself in its comparison of these arrangements :

" As regards the greater part of goods of large tonnage, transhipment by means of a sunk or raised track offers tangible advantages over the level system. It is more rapid, more economical, and also less laborious for the workmen charged with the transhipment. These advantages are particularly noticeable in the case of goods in bulk, such as coal, mineral ore, sand, beet, etc., which are transhipped by means of either shovel or pitchfork, and a considerable portion of which falls of itself, when the side doors of the truck are opened, along the tranship shoots into the truck which is being loaded.

" On the other hand, the system of transhipment by sunk or raised tracks has some drawbacks, as for instance in the case of heavy and bulky goods, and again in that of goods likely to suffer deterioration through clashing together.

" In the first of these categories come goods in tightly-compressed bales, the weight of which sometimes exceeds 200 kilograms (440 lb.). In the transhipment of such goods by sunk or raised tracks, special precautions are taken, these consisting chiefly in the use of cords and hooks by means of which the first bales are held in check; after which the remainder can be allowed to fall without fear of damage, the shock they sustain being deadened by those already below.

" The second category comprises the major portion of goods conveyed in sacks.

" It is usually preferable to tranship at a level these two descriptions of goods.

" Finally, transhipment at a level imposes itself in the case of nearly all manufactured goods of every description, whether carried in bulk or in any kind of packing.

" When it is a question of transhipmenl at a level of bales, sacks or cases, the two

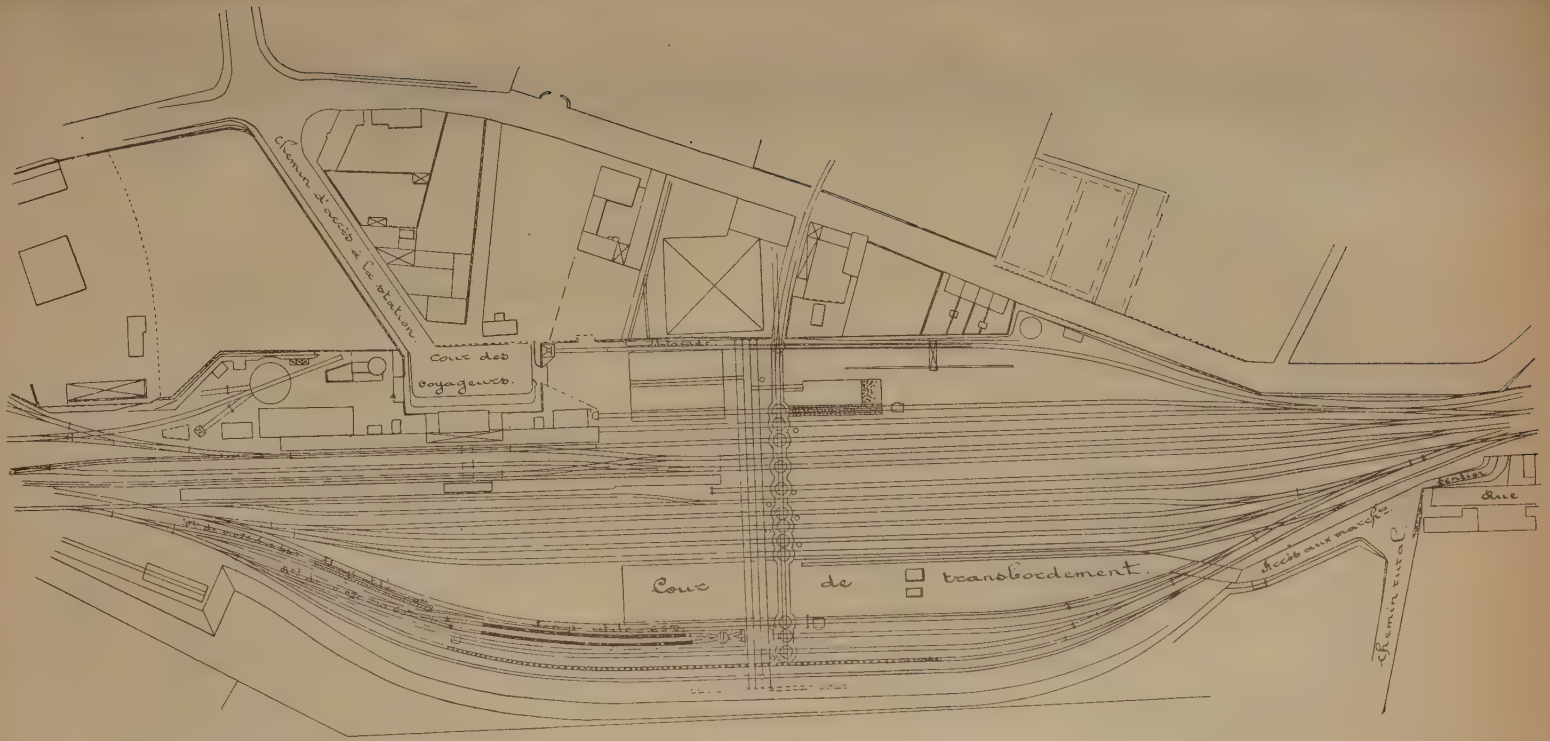


Fig. 28. — Doullens station. Transhipment arrangements.

REFERENCE :

Sunk track of Economic Railway.

Raised track of Economic Railway.

Level track of Economic Railway.

Explanation of French terms : Chemin d'accès à la station = Roadway to station. — Cour des voyageurs = Passenger Office. — Estacade = Raised track. — Cour de transbordement = Transhipment yard. — Accès aux marchandises = Access for goods. — Sentier = Path. — Rue = Road. — Chemin rural = Country road. — Long^{r} utile = Available length.

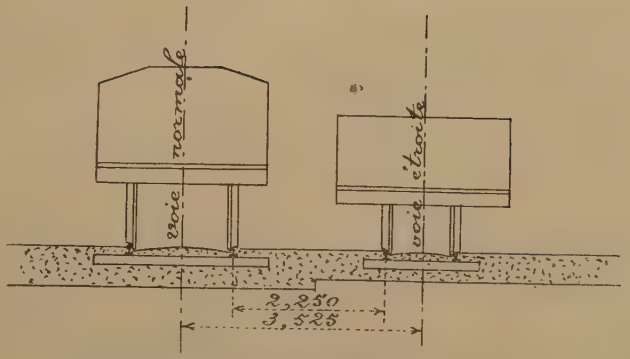


Fig. 29. — Transhipment at the same level.

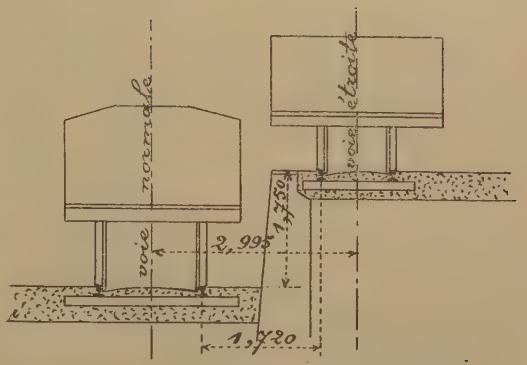


Fig. 30. — Transhipment by raised track.

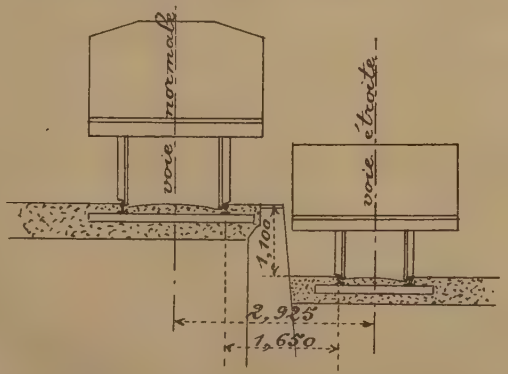


Fig. 31. — Transhipment by sunk track.

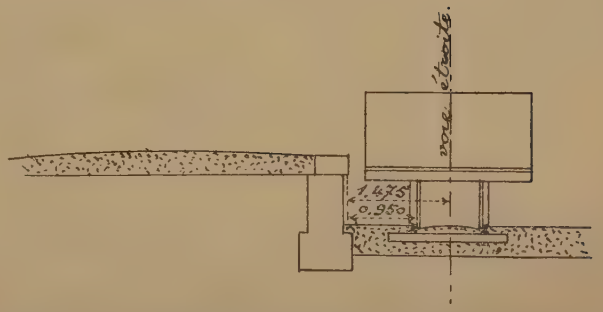


Fig. 32. — Transhipment upon a platform.

Explanation of French terms : Voie normale = Standard-gauge line. — Voie étroite = Narrow-gauge line.

trucks are united by means of a transhipment bridge, upon which one man suffices to pass the goods on by means of a pinch-bar.

" In the case of other goods, the transhipment is effected by hand, all necessary precautions being taken.

" The net cost of transhipment varies according to the district and the nature of the goods. It is estimated that for coal, mineral ore, sand, etc., the cost is from 20 to 30 centimes per ton (1·95*d.* to 2·93*d.* per English ton). For delicate or light goods, the cost does not go below 30 centimes per ton (2·93*d.* per English ton).

" Transhipped goods never suffer damage, practically speaking, through the process of transhipment, and compensation under this head is exceptional and absolutely trifling. In any case, we have never lost traffic over the question of transhipment."

Orleans Railway.

The method of exchange most frequently adopted is transhipment at a level, supplemented very often by a travelling crane serving both tracks, and facilitating the transhipment of indivisible masses of goods of a certain weight. Neither sunk nor raised tracks exist, except in a very limited number of exchange installations; such is the case, however, at Villefranche-d'Allier (line from Sancoins to La Peyrouse, General Light Railway Company), where are annually transhipped about 10,000 tons of fuel brought by the narrow-gauge line. The latter uses side-tip wagons, and the load is shot into the trucks of the standard-gauge line (see figs. 33 and 34). As a specially-interesting case, the Orleans Railway cites that of a consignor of slates who packs his goods into frames holding 5 tons, the frames being manipulated by means of a crane. This procedure has the effect of reducing the duration and risk of damage of the transhipment.

Paris-Lyons-Mediterranean Railway.

This system includes ninety exchange stations serving narrow-gauge lines.

In nearly the whole of these stations, transhipment is effected exclusively at a level: there are extremely few examples of sunk or raised tracks.

Carrying-trucks are in use at the station of Genève-Cornavin (Geneva Company of electric tramways), and give good results there.

The section from Bourbon-Lancy (station) to Bourbon-Lancy (town), having a length of about 2,500 metres (1·5 miles) and forming part of the narrow-gauge line from Bourbon-Lancy to Toulon-sur-Arroux (departmental railway), has been epuipped with four rails for the purpose of avoiding the transhipment of goods between the main line and the town of Bourbon-Lancy. The goods which have in this way escaped transhipment reached, in 1907, a total of about 500 trucks (235 of these being cattle-trucks).

Fig. 34. — Longitudinal section.

Fig. 33. — Cross-section.

Figs. 33 and 34. —

Explanation of French terms : Appareil basculeur (7 poteaux supports = Tipping apparatus (7 supporting posts). — Estacade = Raised track. — Rampe d'accès (voie économique) = Slope of access (Economic line). — Voie P. O. (palier) = Level Run Paris-Orleans line. — Fosse = Sunk track. — Voie Economique en fosse = Sunk track (Economic Railway). — Voie P. O. = Track Paris-Orleans. — Wagons P. O. = Trucks Paris-Orleans. — Voie Economique sur estacade = Raised track (Economic Railway). — Chemin de roulement = Rolling path. — Wagon Economique basculant = Tip wagon (Economic Railway). — Appareil basculeur = Tipping apparatus.

French Western Railway.

Of the thirty-three stations connected with narrow-gauge lines, that of Chateaubriant alone is furnished with sunk and raised tracks; the whole of the others permit of the level method only. The special installations at Chateaubriant are designed to facilitate the transhipment of limestone brought by the narrow-gauge line on tip-wagons. The operation is very rapid (a few minutes suffice for four men to tranship 9 tons of limestone) and the net cost does not reach 10 centimes per ton (0·98*d.* per English ton).

For the transhipment from the standard-gauge trucks into the narrow-gauge trucks, the sunk-track arrangement, with shovelwork (notably in the case of fuel), is used at a net cost of 15 centimes per ton (1·46*d.* per English ton).

In the various stations where transhipment is effected at a level, the average net cost is 20 to 30 centimes per ton (1·95*d.* to 2·93*d.* per English ton).

For the conveyance of slates brought to the main line by the Britanny narrow-gauge system, metallic frames or cases are used similar to those referred to above in connection with the Orleans railway. These cases can hold 3,000 kilograms (6,600 lb.) of slates each; their weight is 340 kilograms (750 lb.) and their price 275 francs (£11) a piece; their dimensions (2·00 × 1·75 × 0·60 metres [6 ft. 1 $^{3}/_{4}$ in., 5 ft. 8 $^{15}/_{16}$ in., 1 ft. 11 $^{5}/_{8}$ in.]) permit of three of them being placed upon a flat truck of the narrow gauge line (see figs. 35 to 38).

These cases give very satisfactory results; they are used for the conveyance of 7,000 to 8,000 tons of slates per annum.

Somain-Belgian Frontier Railway (Mines of Anzin Company).

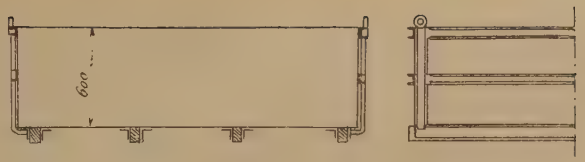
This railway (of standard-gauge) brings to the exchange stations of Anzin and Denain coal which has to go on by the narrow gauge line.

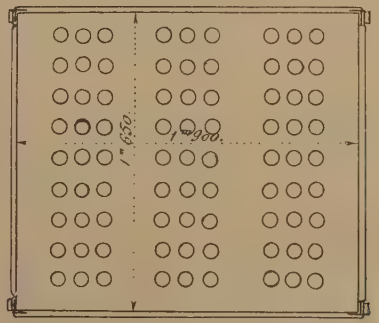
At Anzin, where the quantity exchanged is about 5,000 tons per annum, transhipment from the larger trucks into the smaller is effected at a level in accordance with the usual procedure, and costs 20 centimes per ton (1·95*d.* per English ton).

But at Denain (Renard sunk track), where there is an annual traffic of about 60,000 tons, recourse is had to a special arrangement; the coal is loaded into movable truck-bodies placed upon a truck (of standard-gauge) as shown in figures 39 and 40; each truck-body holds about 1,700 kilograms (3,750 lb.); the total load of a vehicle is six truck-bodies, that is to say 10,000 kilograms (22,000 lb.) net.

A steam-crane raises in succession each truck-body, and swings it into a ten-ton narrow-gauge high-sided truck placed upon a track 8 metres (26 ft. 3 in.) distan from the standard-gauge line.

The net cost per ton transhipped is 8 centimes (0·78*d.* per English ton).





Figs. 35 to 37.

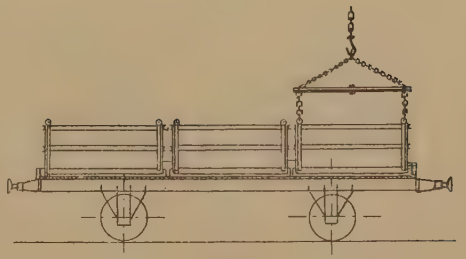


Fig. 38.

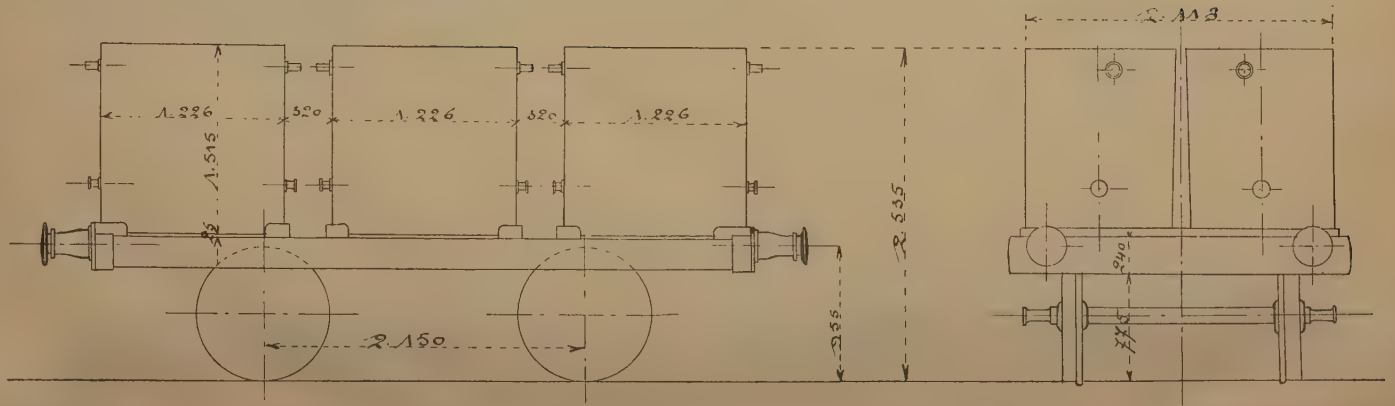


Fig. 39.

Fig. 40.

X. — GREAT BRITAIN AND IRELAND.

A. — UNITED KINGDOM.

In the United Kingdom there are few lines of narrow gauge; transhipment installations are naturally, therefore, not very numerous,

The Great Eastern Railway informs us of the existence upon its system of one single exchange station (Halesworth), at which the traffic is in any case of little importance, and which adopts the level system. It is likewise this method (but with a transhipment platform set on a level with the floors of the trucks) which exists at Ennis and at Tralee (Ireland) at the stations of exchange dependent on the Great Southern & Western Railway.

In Wales, three exchange installations with the Great Western Railway serve the lines from Festiniog (gauge, 0·60 metre [1 ft. 11 5/8 in.]) from Glyn Valley (gauge, 0·70 metre [2 ft. 3 9/16 in.) and from Rheidol (gauge, 0·60 metre [1 ft. 11 5/8 in.]).

In the case of the latter line (annual traffic exchanged 1,000 tons), transhipment is effected solely at a level, but in the two others there is, in addition, a raised-track arrangement, the traffic to the main lines (slates at Festiniog and broken stone for the maintenance of roads at Thirk) being much more important than the traffic in the contrary direction (8,500 tons of slates at Festiniog annually and 17,000 tons of broken stone at Thirk). At Thirk the discharge of the broken stone from the small trucks into the large is effected mechanically, the first being provided with tip sides; thanks to this arrangement, two men can in ten minutes tranship 10 tons of broken stone.

Finally, the North Staffordshire Railway notifies us that the line (recently opened) from Warehouses to Hulme End (gauge, 0·75 metre [2 ft. 5 1/2 in.]) uses with success carrying-trucks (upon two bogies) designed to carry upon the narrow-gauge line without transhipment the main-line stock.

B. — INDIAN EMPIRE AND COLONIES.

The following administrations have been good enough to reply to our questions :

North Western Railway of India;
East Indian Railway;
Southern Mahratta Railway;
Bengal-Nagpur Railway;
Madras & Southern Mahratta Railway;
New South Wales Government Railways;
Western Australia Government Railways;
Natal Government Railways;
South African Central Railway.

On these various systems, the arrangement for transhipment generally adopted

is that at a level, the lines of different gauge being either placed close together, or separated from each other by a transhipment platform on a level with the floors of the trucks. One single different system is notified to us by the Bengal-Nagpur Railway as existing at its station of Gondia, where there is an important exchange of mineral ore; the narrow-gauge trucks have a hopper bottom and are placed upon a line (raised track), underneath which are installed shoots conducting the ore into the broad gauge trucks placed below. By means of these shoots and of the hoppers, the manual labour involved in the transhipment is reduced by more than a half, and amounts to 1·25 franc (1*s.*) per ten-ton truck at most.

XI. — ITALY.

Italian State Railway.

Five transhipment installations with narrow-gauge lines exist upon the Italian State Railway system. All use the level system; one among them, however (Schio Station, Venetia), likewise includes an installation for Langbein carrying-trucks, which are used for the service of a saw-mill connected with the narrow-gauge line.

Bari-Barletta Railway.

This line, with a gauge of 0·75 metre (2 ft. 5 $^1/_2$ in.), carries a good deal of wine in casks (about 15,000 tons annually); these goods are transhipped by means of a paved platform placed between the lines of the two gauges. Other goods are transhipped directly from truck to truck by means of the usual level system.

There are transhipped also from truck to truck, by means of ordinary pumps, liquids in tanks, in particular wine and drinking water (1,000 tons annually).

The cost of transhipment is, per ton, 40 centimes (3·90*d.* per English ton) for the wine in casks, 70 centimes (6·83*d.* per English ton) for the liquids in tanks and 35 centimes (3·41*d.* per English ton) for other goods.

Brescia-Mantua-Ostiglia Railway.

This line is of standard gauge, but on account of certain conditions of construction (radius of certain curves too small and rails of insufficient cross-section) main-line stock cannot circulate there; consequently, it is obliged to tranship, at Mantua, goods to be exchanged with the main system. This transhipment is effected by the level method, without any special feature otherwise, and at the cost of 30 centimes per ton (2·93*d.* per English ton).

XII. — LUXEMBURG.

Prince-Henri Railway.

The Prince-Henry Railway receives at three of its stations (Echternach, Noerdange and Grundhof) lines of narrow-gauge. In the two first stations, the exchange

of goods is effected exclusively by means of the level arrangement. The cost of the operation is 2·25 francs (1*s.* 10*d.*) per ten-ton truck at Noerdange. At Echternach the cost reaches 5 francs (4*s.*) for building timber, 3·60 francs (2*s.* 11*d.*) for tiles, bricks and slates, 4·80 francs (3*s.* 8 $^1/_2$ *d.*) for dressed ashlar; it is as low as 1·50 franc (1*s.* 2 $^1/_2$ *d.*) for manure in sacks.

At Grundhof, the narrow-gauge railway has been built exclusively for the exploitation of the quarries of Dillingen. The whole of the traffic of these quarries (15,000 tons per annum) is dealt with by means of carrying-trucks (Langbein type).

The line possesses six pairs of trucks (at 3,500 francs [£140] the pair) and two sunk stowage tracks, the total expense being about 24,000 francs (£960).

Putting the annual outlay for repairs at 500 francs (£20), and the amortization of the capital at 15 per cent, one finds that the use of carrying-trucks burdens the quarry traffic to the extent of 27 centimes per ton (2·63*d.* per Engl. ton), a figure relatively high, but one which would diminish if the line gave its maximum yield.

Alsace-Lorraine State Railway.

The Alsace-Lorraine State Railway receives at Luxemburg station the narrow gauge line coming from Echternach. Transhipment is carried out at a level, at the cost of about 2·50 to 3 francs (2*s.* to 2*s.* 5*d.*) per 10-ton truck.

XIII. — NORWAY.

Norwegian State Railway.

The particulars furnished to us by the Norwegian State Railway relate to three exchange installations (Christiania, Hamar and Trondheim), where the arrangement adopted has been that at a level.

At Christiania use is also made, for the traffic exchanged between the lines of the Western system (standard-gauge) and those of the Eastern system (gauge 1·067 metres [3 ft. 6 in.]), of carrying-trucks of the two gauges : there are five pairs of carrying-trucks for the narrow-gauge and three pairs for the standard-gauge. The note addressed to us by the Norwegian State Railway points out that, chiefly in consequence of the rather long time necessarily occupied in the stowage of the wagons upon the trucks, the use of the latter is ill adapted to a busy service. We presume, therefore, that the use of carrying-trucks is reserved for goods specially difficult to handle, and that the others are transhipped.

XIV. — THE NETHERLANDS.

From the rather summary particulars transmitted to us, we believe we are correct in assuming that the level method is the only one adopted.

XV. — PORTUGAL.

The Portuguese National Railway Company informs us that it possesses two transhipment stations arranged in accordance with the level system. The principal traffic is in corn (9,000 tons each year from August to November at the station of Foz-Fera). The transhipment of these goods costs 1 franc per ton (9·75*d.* per English ton) (1). In the case of other traffic, the cost of transhipment is about 2·50 francs (2*s.*) per truck.

XVI. — RUMANIA.

The Rumanian State Railway possesses two transhipment stations, one at Jassy and the other at Crasna.

At Jassy, where the question is one of transhipment between a standard-gauge (1·435 metres [4 ft. 8 1/2 in.]) and a broad-gauge track (Russian gauge 1·524 metres [5 feet]), the transhipment lines, set at the same level, are separated by a transhipment platform 6 metres (19 ft. 8 in.) in width, fixed at the height of the floors of the trucks.

At Crasna, where there is a narrow-gauge line connected with the Rumanian State System, the transhipment lines of the two gauges are set at the same level. They are separated by a transhipment platform for the purposes of broken loads, and are installed near each other for the exchanges from truck to truck.

The net cost of transhipment is about 30 to 35 centimes per ton (2·93*d.* to 3·44*d.* per English ton).

XVII. — RUSSIA.

The following administrations have replied to our enquiries :

1° Russian Northern Railway;
2° Nicholas Railway;
3° Russian Southern Railway;
4° Transcaucasian Railway;
5° Vistula Railway;
6° Sysrane-Viazma Railway;
7° Riasan-Ural Railway.

On these various systems, the transhipment tracks are always established practically at the same level, and are generally separated from each other by a transhipment platform set at the height of the floors of the trucks.

As a specially-noticeable point, we may mention that at the station of Scharopane (Transcaucasian Railway) there is a raised track for the transhipment of manganese

(1) We presume that the corn in question is in bulk.

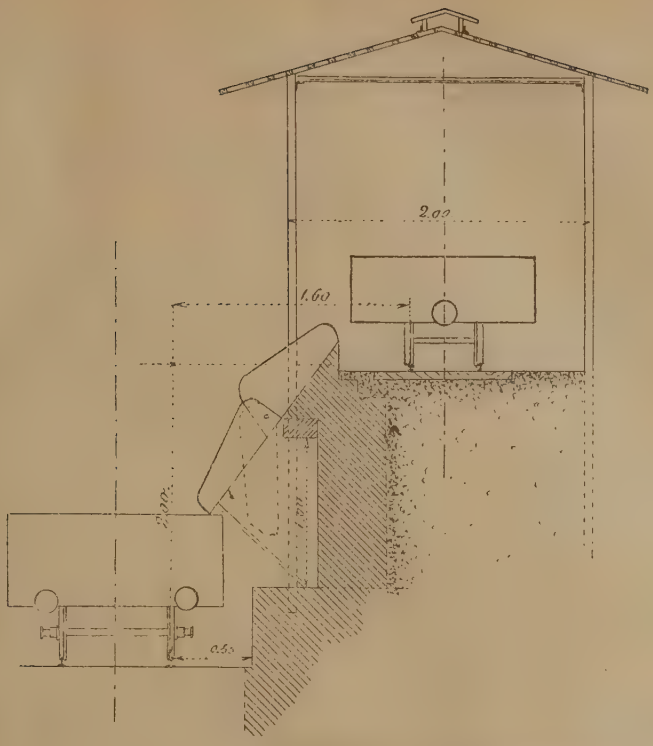


Fig. 41. — Cross-section of raised-track transhipment arrangements.

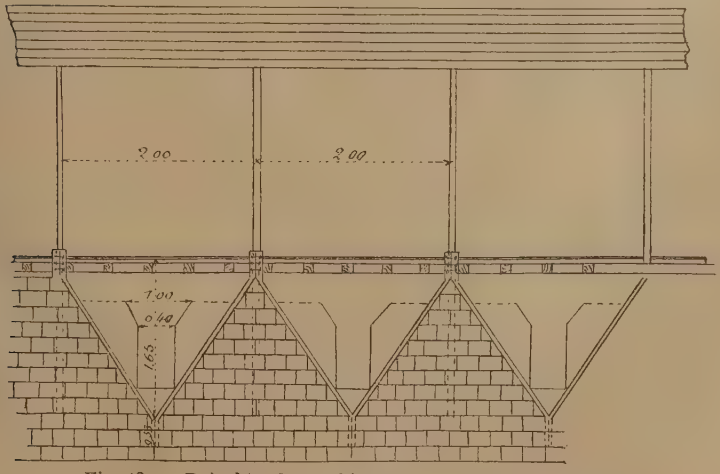


Fig. 42. — Raised-track transhipment arrangement (side view).

*

ore brought by the narrow gauge line. This special traffic amounts to about 600,000 tons per annum; the transhipment costs 1·25 francs (1*s.*) per 10-ton truck. The figures 41 and 42 show this arrangement.

XVIII. — SWITZERLAND.

Swiss Federal Railway.

The Swiss Federal system exchanges goods with narrow-gauge lines at thirty-seven of its stations. These thirty-seven installations all include the level method. In the case of three of them, carrying-trucks of the Langbein type are also used. In no instance has a sunk or raised track been constructed. The transhipment on a level costs on an average 45 or 50 centimes per ton (4·39*d.* to 4·88*d.* per English ton).

The Federal Railway estimates that carrying-trucks may, in particular cases, be used to advantage, as they render it possible to avoid the damage which transhipment may cause to certain classes of goods. But they present certain inconveniences : notably the impossibility of intercalating wagons loaded upon trucks in passenger trains; and thereby involving an extra staff expenditure. Moreover, the dead weight to be carried is greater, a circumstance specially notiaceable in the case of steep gradients.

St. Gothard Railway.

This railway possesses two stations of exchange (Castione and Locarno) with narrow-gauge lines. Transhipment is effected at a level, without special arrangements.

Viége-Zermatt Railway (narrow gauge line).

The exchange station at Viége is included in the thirty-seven indicated above (Federal Railway). Transhipment takes place at a level. About 10,000 tons of goods are exchanged each year during the six months of working.

Rhetian Railway (narrow-gauge line).

This line possesses two stations of exchange (Coire and Landquart) with the Federal system : these two stations are likewise comprised in the thirty-seven referred to above. The level method alone is in operation, and gives complete satisfaction to the lines in connexion and to the public served. The net average cost of transhipment is 43 centimes per ton (4.19*d.* per English ton). No class of traffic is lost to the narrow-gauge line on account of the damage which might be caused by transhipment. The annual traffic exchanged is comparatively large (about 45,000 tons at Landquart).

CONCLUSIONS.

Reviewing as a whole the particulars analysed above, we think ourselves justified in concluding that, in the main, the opinion expressed by the Congress at the 1889 session has not been seriously invalidated by experience, during the course of the considerable development which, chiefly in Europe, the construction of secondary lines of narrow-gauge has made.

Transhipment at a level continues to be adopted in the great majority of cases. It is only right, however, to set forth the fact that the use of carrying-trucks and wagons has been greatly extended, particularly in Germany, where they are utilized at about one-half of the exchange stations dealt with in the replies which have reached us. It may be said of these contrivances that they are practical, and of valuable service in the case of all fragile goods.

Methods involving the elevation of one of the lines of exchange to the height of the trucks of the other line are applicable in every case where important and regular traffic presents itself in certain special products little liable to damage. Such systems are specially advantageous when, for goods of this kind, use can be made of tip-wagons or those with a hopper bottom, so that the amount of manual labour necessitated by the transhipment may be reduced to a minimum.

The arrangements adopted in Denmark and the United States are decidedly ingenious, but for various reasons do not appear to be resorted to very extensively. The same thing applies to the movable truck-bodies used in the mines of Anzin (France).

As regards the arrangements with three or four rails, these have the great disadvantage of being costly; for this reason there can be no question of their use except where important traffic has to be served in the vicinity of the points of junction with the main line. If, on the other hand, the section to be equipped in this way is lengthy, it is more economical and more rational to renounce purely and simply the complexity of a line of double gauge, and to lay down a branch line of standard gauge, provided that very important and remunerative traffic is certain.

To sum up, experience has shown that transhipment from truck to truck by the level method does not constitute, for exchange traffic between lines of narrow gauge and the main railroad, a too onerous charge in ordinary circumstances.

Nevertheless when, in certain special cases, or for certain goods, it is found indispensable to reduce the said charge, carrying-trucks or wagons, sunk or raised track arrangements, the use of tip-wagons and the partial equipment of the narrow gauge line with a track of three or four rails, constitute solutions which experience has proved to be useful and practicable.

APPENDIX.

Detailed list of questions relating to question XX.

1. Do you operate any stations for the exchange of goods from truck to truck between lines of different gauges?

2. If so, please send us plans (scale : 1 in 1,000 or 1 in 500 if possible) of some of them, with lengthwise and crosswise profiles, mentioning the horizontal and vertical distances between the lines used for exchanging traffic, and the measurements of the bodies of the trucks used.

3. If your transhipment arrangements include any sunk or raised tracks, please say so and mention what are the advantages or disadvantages of these arrangements as compared with when the tracks (or at least the floors of the transhipment trucks) are practically at the same level.

4. In the case of the various stations considered above and for the traffic in each direction, what are the principal kinds of goods transhipped and their approximate annual tonnage (or the maximum monthly tonnage if the traffic is such that it varies in quantity according to the season of the year)?

5. Please supply us with some details as to the procedure followed at your stations in transhipment? Do you use any special tools or appliances? Furnish us furthermore if possible with figures regarding the actual cost of transhipment (number of men occupied per 10 ton wagon, time spent in the operation, wages allowed either per hour, or by piece work, etc.).

6. Does your traffic include any goods liable to damage in transhipment? Does such damage involve compensation, or does it result in your losing certain kinds of traffic?

7. With a view to avoid the transference of goods from truck to truck, do you use any special means such as carrying trucks, movable truck-bodies, tracks with three or four lines of rails?

8. If so, please supply us with detailed information about these methods, adding plans or sketches, and give us your impressions about them on the following points :

a) original cost of installation;

b) cost of operation;

c) advantages or disadvantages ensuing both for the industries concerned and for the railway itself.

9. Can you formulate any more or less general rules indicating in which cases each of the solutions considered in your answers is more especially to be recommended?

SECTIONAL DISCUSSION

Meeting held on 9 July, 1910 (morning).

MR. BEHRENS, PRESIDENT, IN THE CHAIR.

The President. (In French.) — Gentlemen, we now begin the examination of question XX. I call upon the reporter to address the meeting.

Mr. de Burlet, *reporter.* (In French.) — Gentlemen, in order to facilitate the arduous task of those entrusted with the translating and the shorthand reporting, I will endeavour to give as brief and concise a summary of my report as possible.

The question of transhipment has already been discussed at several sessions of the Congress and this problem will no doubt remain on its agenda for a long time to come.

This is not surprising. In the first place, it is of considerable importance to all the managements of secondary lines linked with the main railroads; secondly, it is connected with the following important question, often discussed but not yet definitely settled : *What gauge should secondary lines have? The standard gauge or a narrow gauge, for instance one of 1 metre* (3 ft. 3 $^3/_8$ in.)?

A narrow gauge is distinctly cheaper. In our country, Belgium, the figures are as follows : mean cost of a kilometre of standard-gauge secondary line, 102,250 francs (£6,582 per mile); ditto of a kilometre of metre (3 ft. 3 $^3/_8$ in.) -gauge line, 58,000 francs (£3,734 per mile). On the other hand, a narrow-gauge line has the incontestable disadvantage of making it necessary to tranship the goods at the point where the standard-gauge line and the narrow-gauge line meet.

Is this disadvantage sufficiently serious to lead to the adoption of the standard gauge, in spite of its great cost? That is the problem. It is evidently impossible to give a general and uniform solution of it, but it must be dealt with in each individual case with great care, taking all special circumstances into consideration, such as the importance and the nature of the traffic, the length of the line, etc.

In our country, *we have been led to adopt the narrow gauge in nearly every case.*

Out of our 164 lines having a total length of 4,482 kilometres (2,785 miles), we have the standard gauge only on three lines with a length of 39 kilometres (24·2 miles), and we are convinced that if

we had adopted the standard gauge in most of the cases, we should have met with such financial difficulties in trying to raise the capital necessary, that we should have hardly been able to build one third or even one fourth of the existing system.

What would have been the result? That under the pretext of wishing to do *better* for the districts and populations which are scattered and isolated, one would have done *nothing* and they would have had to wait, for goodness knows how many years, before they were connected up by cheap and rapid ways of communication with the main railroad system.

Now it is well known that the development of the prosperity of a district, from the commercial and industrial point of view, is impossible when that district is isolated and only cart traffic is available.

We only adopted the standard gauge in the following case; when it was a question of lines of limited length, which had to deal with a busy traffic of heavy goods.

It is readily intelligible that in such cases the cost of transhipment, even if small, would be too heavy a burden on the goods carried, by increasing the total cost per kilometre unduly.

Hence, we have preferred the narrow gauge in our country, and the same has been the case in many others.

Let us, moreover, note that if as a result of the construction of the narrow-gauge railway, new industries have arisen, or if the existing industries have become developed, and with them the traffic, to such an extent as to justify the standard-gauge on part of the line, nothing prevents the equipment (but at that time only, and then one is safe and certain to remunerate the capital required) of part of the line with three or four lines of rail, so as to save the trouble and expense of transhipment of the heavy goods.

That has been done in Belgium in various cases. As yet there have not been many of them, but this proceeding is entirely rational and justifiable.

My report contains particulars of this interesting solution.

Nevertheless transhipment has disadvantages, and although I am in favour of the narrow gauge, I am careful not to deny this. These disadvantages have to be remembered by all who have to do with light railways and it is not surprising that everywhere attempts are made to reduce them to a minimum.

This explains, I repeat, why this question remains on the agenda of our sessions.

It is however important not to exaggerate these disadvantages, and thereby the disadvantages of a narrow gauge.

To begin with, there is this important fact: these disadvantages are nil as far as passenger traffic is concerned, and this is already a great deal, as passenger traffic yields the greater part of the total gross receipts of the light railways.

In Belgium, in the financial year 1909, the proportion was: passengers, 62 per cent; goods, 38 per cent.

And as regards the goods, what is the cost of the transhipment? From 15 to 25 centimes per ton (from 1·46*d.* to 2·44*d.* per English ton) when the simplest and cheapest methods are used.

That is very little and I continue to believe that in the case of ordinary goods, not liable to loss or damage, special de-

vices, generally of an expensive and complicated character, are not justifiable.

That has been the opinion of our Congress at its different sessions, and has also been the opinion of the tramway and light railway congress.

Subject to these necessary reservations, I think that in order to take the problem as a whole, from the general point of view, I must now consider more especially the subject we have to discuss, which is worded as follows :

Examination of the different systems adopted for the exchange of goods between lines of different gauges (transhipment at the same level, sunk or raised tracks, trucks for taking cars of another gauge, tracks with three or four lines of rails, etc.).

The question which we have to discuss today thus includes more especially a comparative examination of the different means adopted for transferring goods from a standard-gauge line to a narrow-gauge line, or *vice versa*.

The subject naturally has a descriptive side for which I beg to refer my audience to the different drawings given in my report.

I will accordingly limit myself to giving the main features and the chief characteristics of the different systems which have been applied. There are six of them.

I. — My report contains a summary of the information sent to me from all the countries where railway systems with different gauges are coexistent; it may be concluded from this information that *transhipment by hand on lines at the same level* is by far the most usual method. This is the first system. This method of transhipment is that which makes fewest installations necessary. As I have already stated, it does not cost more than 15 to 25 centimes per ton (1·46*d*. to 2·44*d*. per English ton) on the average. This cost can even be reduced very appreciably in the case of a regular traffic of non-fragile goods, such as the raw materials required for industrial purposes generally are.

II. — When the interchange traffic on a narrow-gauge line becomes specialized in such a way that it includes a large tonnage of goods *of one and the same kind*, it may happen that in spite of the low unit cost of transhipment, the total cost of the latter for the whole of the annual tonnage represents a comparatively large sum. In cases of this kind, it is evident that those concerned investigate whether special appliances will enable them to effect a saving in this expenditure. It is for this reason that in order to use gravity so as to facilitate the work of transhipment, the narrow-gauge line has been raised relatively to the standard-gauge line if there is an important traffic brought by the former, or sunk if the traffic is brought by the latter. This method is often adopted at the stations of the French Northern Railway; it has, however, sundry disadvantages as regards the good preservation of the rolling stock and of sundry kinds of goods (coal, for instance). It is sometimes supplemented by the use of hopper wagons or of wagons with movable sides. It is also possible to have a movable floor, so as to have practically complete self-discharging; but then it is necessary to have the narrow-gauge line vertically above the standard-gauge line. Thus we have the arrangement at Kerkerbach station, in Germany.

III. — With the same object of reducing

the labour in the case of goods not easy to handle, gantry cranes are used extending across both the standard-gauge and the narrow-gauge lines. These appliances are used chiefly for the transhipment of logs of timber, parts of machines, etc. In those cases, the tracks can be left at the same level and the handling of the goods is facilitated by the mechanical appliances. My report describes several installations of this kind existing in Bavaria and in Wurtemberg. In France, the use of cranes is combined, at certain stations, with the use of truck-bodies for holding coal, or special frames for holding slates; these holders, together with their contents, are easily lifted by the crane from the flat wagons of the standard-gauge line to those of the narrow-gauge line or *vice versâ*.

Movable truck-bodies are also found, as described in my report, on a Danish line; but there they are not operated by means of a crane. They are mounted on wheels and so can be run endways from one flat truck on to another of a different gauge.

IV. — Finally, in the United States, advantage is taken of the ease with which wagon bodies can be detached from the bogies which carry them; by means of a very ingenious system of sunk track, the bogies are replaced by others of a different gauge.

V. — Strictly speaking, there is no transhipment of goods in the latter cases; nor is there any when carrying-trucks are employed, as they are on the large scale in Germany, where carrying-trucks are used for conveying standard-gauge wagons to and from works connected by narrow-gauge lines only. The objection often raised against these trucks is that they materially increase the dead weight which has to be hauled on the narrow-gauge line; but this objection has not prevented this system from being frequently applied on lines where fragile goods have to be exchanged. The most typical instance of the use of carrying-trucks is beyond doubt that of Forst in Brandenburg; there more than 23,000 wagons are annually loaded on carrying-trucks and hauled over seventy-seven different branch lines.

It is questionable whether it would not have been better to adopt the standard gauge, seeing the large quantities involved.

VI. — I still have to mention, in order to complete my summary, the arrangements with three and four rails, utilized in certain rare cases, chiefly in Germany and in Belgium. These arrangements are expensive and their use seems to clash somewhat with the quality of cheapness which narrow-gauge lines are generally intended to possess. They can accordingly only come in question in the case of very important traffic of a special kind, carried for short distances.

To sum up. experience has shown that transhipment from truck to truck by the level method does not constitute, for exchange traffic between lines of narrow-gauge and the main railroad, a too onerous charge in ordinary circumstances.

Nevertheless when, in certain special cases, or for certain goods, it is found indispensable to reduce the said charge, carrying-trucks or wagons, sunk or raised track arrangements, the use of tip-wagons and the partial equipment of the narrow gauge line with a track of three or four

rails, constitute solutions which experience has proved to be useful and practicable. (*Long applause.*)

I venture to send round some photographs which show you the arrangement of a four-rail line and an intercalating wagon equipped with two couplings, as well as photographs of a train consisting of a standard-gauge wagon hauled by a narrow-gauge locomotive.

The President. — I declare the discussion opened. I again remind the members of the section that they are requested not to speak until they have applied to the president and been requested to by him to do so; they are also requested to stand up when they address the meeting. It is indispensable that these rules should be observed, so that the discussion may be an orderly one, and not degenerate into a series of interruptions which would make the discussion incomplete and confused.

Mr. Campiglio, Italian Union of railways of local interest. (In French.) — I desire to address the meeting.

The President. (In French.) — Mr. Campiglio will address the meeting.

Mr. Campiglio. (In French.) — In Italy, the question of carrying-trucks has been investigated. As this question is connected with that of transhipment, I ask your permission to say a few words about it.

The nature and the quantity of the traffic has to be taken into consideration, the mean distance the goods are carried and the conditions affecting the exchange of rolling stock.

In Italy, the conditions relating to the hiring of the rolling stock are generally very onerous, and the situation has been made still more onerous by the administration of the State Railway.

In Germany, in Austria, in France and in other countries, twenty-four hours are generally allowed free of charge, but in Italy, in most cases, only six to eight hours are granted. Accordingly, it is necessary to tranship as quickly as possible, or else expense is incurred. It is advissable to recommend all administrations who make such conditions to be more reasonable and more equitable to the light railways, so that the latter can develop, as is desirable.

The state of affairs has been very fully described by Mr. de Burlet. I accordingly limit myself to the request that a short clause should be added to Mr. de Burlet's conclusions; the clause to run as follows :

" In investigating the question whether it is advisable to adopt the special installations mentioned in the preceding clause, consideration has to be given to the quantity and to the nature of the goods, to the distance they have to be carried and to the conditions relating to the exchange or hire of the rolling stock used for those goods (dues which have to be paid, time of utilization of the wagons, etc.)."

Mr. de Burlet. (In French.) — I propose to examine this amendment when we start discussing the wording of the conclusions which are to be submitted to the general meeting.

Mr. von Ziffer, Lemberg-Czernowitz-Jassy Railway, Austria. (In German.) — This question, which has been described

as " that night mare of the cost of transhipment ", does not seem to have sufficient importance to lead one to refrain from obtaining concessions for building and operating narrow-gauge railways. In the use of carrying-trucks, I see a very annoying increase in the cost of carriage; as, on the other hand, the maximum moving dimensions are the same as on standard-gauge lines, the cost of construction becomes greater; moreover, the dead weight which has to be hauled becomes greater. Finally, while admitting that the use of carrying-trucks is an unavoidable evil when certain fragile goods have to be carried, I would remark that this evil is aggravated by the fact that according to the Austrian regulations now in force, only one single carrying-truck may be used per train, and that truck must be fitted with a brake.

I therefore should like to know whether the same or similar regulations exist in other countries, and also whether the cost of transhipment is included in the rates of your tariffs, or charged separately to consignors.

Remarks made by different delegates seem to imply that such hampering regulations do not exist, and that the cost of transhipment is charged separately in most countries, the consignor or the consignee having the option of having the tranship operations carried out by his own men, if he considers this advisable. In British India, the cost of transhipment in included in the tariffs; in calculating the rate, 3 miles are added to the distance.

Mr. de Burlet. (In French.) — I will at once answer the remarks that have been made, so as to simplify the discussion.

Mr. Campiglio proposes to add a clause to the conclusions which I have had the honour to submit to the section.

I propose to wait until the general discussion is finished, before discussing this amendment. (*Approval.*)

Mr. von Ziffer asks how the charge for transhipment is setled in other countries. In Belgium, it is fixed at 25 centimes per ton (2·44*d.* per English ton); special regulations exist about the subject. The cost of transhipment is always added to the rate, and it is paid by the consignor or the consignee. But all this is known to the parties concerned; it is specified in the rules and conditions of the tariffs.

I add, and this is very important, that the consignor has the right to carry out the transhipment operations himself. Let me assume that the consignor prefers not to pay the charge of 25 centimes per ton (2·44*d.* per English ton); he then has the right to send a gang of men to the transhipment station to carry out the tranship operations; he then does not pay the charge of 25 centimes per ton.

Mr. von Ziffer. (In French.) — That is just the same with us.

Mr. du Beaufret. Bône-Guelma Railway, Algiers. (In French.) — The question of the transhipment is of particular importance to the Bône-Guelma Railway Company. We have a very busy traffic on about 235 kilometres (146 miles) of line. The first 128 kilometres (80 milles) are narrow-gauge line; the next 107 kilometres (66 miles) are standard-gauge line. We carry per year over 300,000 tons of heavy goods, chiefly phosphates. The transhipment, although it takes places at 128 kilometres (80 miles) from the sending station

and at 107 kilometres (66 miles) from the receiving station, is carried out, according to the conditions of the tariff, by the consignor, who succeeds in carrying out these operations at a cost of about 15 centimes per ton (1·46*d.* per English ton) in the case of phosphates. All that we have done is to raise the narrow-gauge track in order to facilitate the transhipment.

We have begun an investigation which is not without interest. The two parts (narrow-gauge and standard-gauge) of the line considered are not subjected to the same traffic rules. On the narrow-gauge line, we carry practically only heavy goods, while on the standard-gauge line we carry goods of all kinds and, more particularly in summer, cereals in large quantities. It sometimes happens, during the cereals season, that there is a shortage of standard-gauge wagons for transhipments from the narrow-gauge to the standard-gauge line. Attempts have been made to solve this difficulty and the following suggestion has been made; would it not be possible to prevent any delaying of the narrow-gauge wagons, although there is a shortage of standard-gauge wagons? It is proposed to erect at the transhipment stations hoppers of large capacity and store the phosphates arriving on the narrow-gauge line. The train on the narrow-gauge line arriving on the raised track is at once emptied into these hoppers and the narrow-gauge wagons are then sent back at once. The hoppers would subsequently discharge their contents into standard-gauge wagons when these are available. In this way, the standing idle of the narrow-gauge wagons would be prevented.

An objection arose not on account of the number of phosphate companies (there were only two and definite hoppers could have been provided for each of them), but above all on account of the fact that the phosphates varied in quality. That was the chief objection, for at different seasons the quantities of phosphates of a given quality vary.

Mr. de Burlet. (In French.) — The system then did not succeed?

Mr. du Beaufret. (In French.) — We have not applied it; it was merely suggested, as I stated.

Mr. de Burlet. (In French.) — Oh, then it is as a question of a suggestion only, so let us not press it. It is better for us to discuss actualities, sanctioned by practice or made the subject of serious experiment, than simple ideas. The latter may be very interesting, but in my opinion we must wait until this system has been applied, before we examine and discuss it.

Mr. Charignon, Ministry of communications, China. (In French.) — Gentlemen, I ask your permission to express myself in French, hoping that at some future session you will allow me to do so in Chinese. (*Laughter.*)

The empire of China, from the point of view of its railways, is still in the period of construction; the total length of the lines in operation does not exceed 5,000 kilometres (3,100 miles) and all are of standard gauge, namely 1·45 metres (4 ft. 9 in.), except one line. The latter is a metre (3 ft. 3 $^{3}/_{8}$ in.)-gauge line, about 250 kilometres (155 miles) in length, and connects the capital of the province Shansi with the main line from Peking to Han-

kow; it conveys the coal from a very rich coal field to the plains of China and carries up to 2,000 tons of it per day.

Accordingly, the question of transhipment at once arose as being of great importance, and rather than adopt the different systems described by Mr. de Burlet in the report he has presented to us, we have tried to eliminate transhipment by using special wagons with axles of adjustable length. In doing this, we have simply applied to the carriage of goods the excellent solution which makes it possible for the train of His Majesty the Tsar of Russia to pass from the Russian lines on to the European lines, where the length of the axles differs by about 9 centimetres (3 $^{9}/_{16}$ inches). The problem was however more difficult with us, as we had to provide for a difference of 0·45 metre (1 ft. 5 $^{11}/_{16}$ in.) between the two gauges.

The concessionary company had several different patterns designed and constructed in China itself. All gave very good results, and were adopted definitely after a total mileage of over 10,000 kilometres (6,200 miles) on the standard gauge. They give every satisfaction, although they run through districts in which the winds, which often occur during five months of the year, carry a lot of powdery sand; the only objection that can be possible raised is that their lubrication requires more attention (1). All these wagons are on two bogies; the system with automatic closing is preferred by us.

(1) *Additional note by Mr. Charignon*, dated 1 September 1911 : " Improvements have been made " which render the lubrication as simple a matter as " in the case of ordinary wagons ".

In Europe, you have hydraulic installations for passing from one gauge to another, and these make the matter easy; in China, the Chang-Tai Railway Company, if I may mention the name, has adopted as solution a very simple and above all very economic installation.

Assume a short piece of narrow-gauge track AB, the centre line of which forms a continuation of the straight line which is the centre line of the standard-gauge track CD. The ends of the two tracks are about 80 metres (88 yards) apart, and they are connected by two converging lines of rail, which have check rails along them on the inside. The length of 80 metres can be reduced; it must, however, be remembered that the smaller the angle between the two converging rails, the less the flanges will grind against those rails or the check rails, and the less those flanges will become worn. It is in fact only the resistance opposed to the flange either by the outer rail or by the inner check rail which gradually forces the wheels nearer together or further apart. The operation is done in the one direction or the other, as in fly-shunting, and it takes less than a minute to make a wagon pass from the one track to the other.

I am unable to give you any details about the design of these adjustable bogies; they are patented and belong to the concessionary company, 9, rue Chauchat, Paris, and to the Baume & Marpent Company, Haine St. Pierre, Belgium.

I have simply wished to draw your attention to an interesting experiment, but several remarks have to be made :

With us, it is a narrow-gauge company which has taken the initiative and adopted rolling stock with adjustable bogies, but

should it not rather be the main railroad which should have such rolling stock, in order to supply it to the different narrow-gauge feeders from whom it receives part of its traffic, and to distribute it amongst them in accordance with their respective needs? This cannot be left to the narrow-gauge lines, for it represents an expenditure which is much too heavy for many of them, and also because they would run the risk of not always having a return freight on the main lines over which the wagons had been sent.

This elimination of the transhipment certainly appears to be the only way of satisfying everybody, as it does away with all handling, that is with all chances of breakage, damage, etc., and eliminates all loss of time caused by transhipment and by delays at the exchange stations.

Accordingly I have the honour to submit to you the following resolution :

" The great railroad companies are requested, with a view to the development of the traffic they get from narrow-gauge lines, to try to eliminate transhipment and to place at the disposal of the narrow-gauge feeder lines, rolling stock with adjustable wheels and axles, which can run on both gauges, as has conclusively been shown to be possible, in China. " (*Applause.*)

Mr. de Burlet. (In French.) — That is very interesting.

Mr. L. G. Gordon, Moscow-Kiew-Voronetz Railway. (In German.) — In Russia the consignor is generally not authorized to attend to the transhipment himself. The charge made for this operation is generally much higher than the figure previously mentioned; it amounts to $^1/_2$ copeck per pood, or about 8*d.* per ton.

Mr. de Burlet. (In French.) — I quoted the cost of transhipment in Belgium. As regards Russia, I have reproduced the information supplied to me by the Russian administrations. On page 36 of my report (1), I express myself as follows : " This special traffic amounts to about 600,000 tons per year; the transhipment costs 1·25 franc (1*s.*) per 10-ton truck." That is 12·5 centimes (1 $^1/_4$ *d.*) per ton. If there is an error, I am not responsible for it. I thought that owing to the great quantity (600,000 tons per year), very favourable results had possibly been attained. Consequently, we can but take note of the correction which has just been made.

Mr. Waechter, Vering & Waechter Company, Germany. (In German.) — In Wurtemberg, the regulations require every carrying-truck to be fitted with a special brake. In spite of this regulation, no type has yet been found which does not give trouble. The brake can only be at a small height above the ground; consequently, it is often damaged by the stones of the roadbed or at the level crossings, and its action is often unsatisfactory; it only acts on one or at most two of the axles of the bogies. Accordingly, we have tried to make other arrangements, and the regulations at present require every carrying-truck to be preceded by a wagon with ordinary brake. This measure has given good results. With us it is not

(1) See also *Bulletin of the Railway Congress,* 1910, January, p. 464.

prohibited to have several such carrying-trucks on one train, while the contrary is the case in Austria. In the case of certain articles of a particularly fragile nature, such as pottery, we come to an agreement with the manufacturers to attend to the transhipment themselves.

Mr. Jesser, *principal secretary*. (In German.) — Allow me to add a short remark to the report. It so happens that the answers do not express the fact that after all carrying-trucks form a good means of communication between standard-gauge and narrow-gauge lines. The only answer given in this connection is that of the administration of the Prussian State Railway, which considers that carrying-trucks do not suffice for transhipment purposes, as their use is limited to certain well-defined cases. Now there is a number of smaller lines where the regulations concerned are not so inconvenient as has been asserted.

In Austria, as Mr. von Ziffer has already informed us, only one carrying-truck is allowed per train. In many cases that suffices perfectly. If we consider the small lines where perhaps three or four trains run in each direction per day, which do not cater for rich industrial distructs, we find that from 1,000 to 1,200 wagons can be hauled per year. In Austria, these wagons are taken by mixed trains. The train may very well include passenger carriages, without this preventing 30,000 to 40,000 kilograms (66,000 to 88,000 lb.) of goods from being hauled per day. In Austria, carrying-trucks are not braked, and as far as I know, no attempts have yet been made to utilize this safety device. This, moreover, has not led to any trouble. It is true that the speed is limited to 15 kilometres (9·3 miles) per hour; but this again does not inconvenience short lines, for there are sundry other reasons against adopting a higher speed limit, particularly if the line is laid wholly or in part on the highway, or if there are sharp curves, such as are necessary if the cost of construction of lines of this kind is to be kept low.

Mr Waechter has stated that there may be several carryings-trucks on one and the same train; it would be interesting to hear how those trucks are coupled up. The report gives us no information about this point; probably the reporter has received no information about it.

Mr. Waechter. (In German.) — As regards the coupling up of carrying-trucks, I may inform you that stiff coupler bars of different lengths are used. They are placed between the trucks and connected in the ordinary way, by means of a knuckle pin passing through a hole and kept in place by a cotter.

Colonel Bonham Carter, Madras & Southern Mahratta Railway, India. — In India, there are four different gauges and transhipments therefore tend to be more numerous than if there were only two as in Belgium.

The Government fixes maximum rates for all railways based on mileage plus terminals and authorizes an optional charge as for three miles for transhipment at a junction where there is a break of gauge.

As a general rule, no charge is made for transhipment but when a charge is levied it is included in the through rate and not shown separately.

Mr. de Burlet. (In French.) — The rate for 3 miles.

The President. (In French.) — The charge is included in the general rate.

Mr. de Burlet. (In French.) — The distance charged for is increased by 3 miles, that is about 5 kilometres.

The President. (In French.) — Quite so.

Mr. de Burlet. (In French.) — But it is a single charge.

Colonel Bonham Carter. — The rule that no charge is made is not absolute but a charge is exceptional.

Mr. Chassin, French Southern Railway. (In French.) — The information which has just been given is very interesting from the point of view of new countries where new lines are being built, but I do not think that in our European countries, where there are lines in all directions, it is possible to use wagons with bogies with adjustable wheels and axles on narrow-gauge lines.

In my opinion, transhipment is necessary and will always be necessary. What is required, is to find practical means for transhipping bulk goods as cheaply as possible.

I show on the blackboard the design of a self-discharging wagon with a bottom of inverted V shape, which makes it possible to unload bulk goods such as ore, coal, phosphate, etc., with great rapidity. The wagons are brought on to a raised track, the side doors are opened and the goods fall either into hoppers or directly into a standard-gauge wagon. The angle at the bottom is about 30°.

The operation is very easy. A whole train can be emptied in a minute. That is a simplification in the handling which effects a considerable saving.

We have a project of constructing hoppers capable of taking 2,500 to 3,000 tons; but that can only be done in the case of a very big traffic which such stores would help to equalize.

As regards tracks with three rails, we have about 150 kilometres (93 miles) of such tracks on our lines; but it is nearly impossible to work simultaneously with rolling stock of both gauges. One does not yet know any practical method of traction on such three rails; there is always a sideway pull which leads to risk of derailment.

Switches are another great difficulty.

On our lines, the switches are constructed for three rails, and at a given moment one can operate with the standard gauge only.

About twenty years ago, a special commission made experiments in order to determine the resistance of trains on sharp curves. Experiments were made with standard-gauge trains weighing 125 tons (123 English tons) and with narrow-gauge trains of the same weight. The conclusion arrived at was that on curves having a radius of 150 metres (7 1/2 chains) the resistance is greater in the case of the standard gauge and, consequently, operation costs more.

We have also had switches constructed for the four-rail track. These switches cost 10,000 francs (£400) each and it was necessary to give up this idea.

Mr. de Burlet stated that in Belgium 25 centimes per ton (2·44*d.* per English ton), was paid for the transhipment. In France, this averages 30 centimes (2·93*d.*

per English ton) for all goods. It is necessary to try and reduce the labour by putting up cranes, travellers, etc., to do the transhipment.

Mr. Plocq, Société générale des chemins de fer économiques, France. (In French.) — I am an old narrow-gauge operator and I should like to answer the previous speaker who seemed to condemn the four-rail system rather severely. I do not claim that this system can be applied everywhere, but this is what we have done in France.

The French Northern Railway had a standard-gauge line from Noyelles to St. Valéry. The *Société générale des chemins de fer économiques* of France added at each end a narrow-gauge line, and Mr. Emile Level, who was then manager of the *Société*, proposed to the French Northern Railway that it should lay a narrow-gauge line between Noyelles and St. Valéry (so as to ensure the continuity of the narrow-gauge system) and that it should also lease to him the operation of the standard-gauge line between those two points.

Since 1887, the service of the French Northern has been carried out by the *Société générale des chemins de fer économiques*. The narrow-gauge rolling stock is fitted with three buffers, or else a special coupling-up wagon is used.

This system which has now been in use for twenty-three years has never given rise to any trouble.

Mr. Chassin. (In French.) — There is a misunderstanding.

I did not wish to condemn the operation of certain short four-rail sections, for that is a question of kind and it may be very useful to do so ; but I assert that as a general rule when a light railway is to be built, it is better to have a narrow-gauge one, as Mr. de Burlet stated in his report, and to avoid the complication of three or four rails, which renders operation difficult.

Mr. Plocq. (In French.) — I quoted a particular case.

The President. (In French.) — Mr. Suarez, delegate of the Bolivian government, has requested me to inform the members of this section that he is going to distribute among them copies of a note he has drawn up, which will be at their disposal this afternoon.

Mr. de Burlet. (In French.) — In our country, there is no regulation preventing the presence of more than one carrying-truck in a train.

Mr. Jesser has asked me whether this information supplied to me shows that sometimes more than one motor truck is in a train. I have received no definite information about this point, but I am convinced that there are whole trains of motor trucks, if I may judge by the number of trucks which exist on certain lines and by the importance of the traffic which has to be dealt with.

Mr. Chassin has spoken about three-rail and four-rail lines.

The three-rail line shows disadvantages as regards traction, and in our country we hardly use it any more.

When we have to equip a narrow-gauge section for the standard gauge, we prefer to have four rails as soon as the section is no longer a very short one.

We find this system works well.

Mr. Plocq has already answered Mr. Chassin's somewhat summary condemnation. Mr. Chassin stated : " We have also had switches constructed for the four-rail track. These switches cost 10,000 francs (£400) each and it was necessary to give up this idea."

In Belgium, we have had four-rail sections during the last ten years; they work very well and accommodate a considerable amount of traffic.

In the neighbourhood of Liége, we have connected up a coal pit which should give us about 75,000 tons per year; hence, it was worth while making a four-rail track. No doubt, as Mr. Chassin remarked, the track appliances are rather expensive; but such a large traffic fully justifies the expenditure. In the case I refer to, the service is carried out under excellent conditions. We have among us the very able manager of the company which operates this four-rail section, Mr. Philippe, and I feel convinced he will not contradict me when I say that everything goes very well.

Hence I do not wish that the section should remain under the impression that a four-rail track is utopian; thus I confirm Mr. Plocq's statement. It is a reality which may render great services. It is evident that each individual case must be carefully examined, and the cost compared with the receipts to be expected. I may add that the price of our four-rail track appliances is appreciably lower than the figure mentioned by Mr. Chassin.

Mr. Reverdin, who has to do with the light railways of Geneva, wished to be present at our meeting; he is, however, engaged at another section where he is very ably carrying out his duties as secretary-reporter. He has requested me to inform the section what is being done on the Geneva lines. He says :

" In 1896, the narrow-gauge railway company, of which I was then manager, adopted carrying-trucks in order to convey to the spot, in the National Swiss Exhibition, the standard-gauge wagons, so as to avoid transhipment at Cornavin station. In a few weeks before the opening, 240 wagons were conveyed in this way, and after the closing, 290 wagons.

" Branch lines have been constructed since in order to cater for the gas works of the city of Geneva and the commune of Plainpalais, the mills, the engineering works, the tileworks, the provision stores, etc.

" In the *Bulletin technique de la Suisse romande* of 25 July 1905, you will find details about the traffic in question.

" It may be mentioned, as of interest, that this system makes it possible to extend the benefit of the standard-gauge system to establishments whose position was such that it was impossible to connect them with a station by means of a standard-gauge line.

" From the point of view both of gradients and of curves, the narrow-gauge track, owing to its flexibility, when carrying-trucks are used, makes it possible to reach the works, even if they are very badly placed for this purpose.

" The carrying-trucks make it possible to have curves with a radius of 15 metres ($^3/_4$ chain).

" In 1896, the company had six pairs of them in use.

" In 1909, it had eighteen pairs.

" In 1896, it began by carrying 837 wagons in three months.

" The number of wagons then increased as follows : 3,220 wagons in 1898; 5,453 wagons in 1904; 7,500 wagons in 1909.

" There are twelve branches in use; the total tonnage exceeded 90,000 in 1909.

" The transport is generally over short distances, 3 to 4 kilometres (1·8 to 2·5 miles) from the station.

" However, about a hundred wagons (food, wine), are carried a distance of 18 kilometres (11 miles).

" The profit is about 2 to 3 francs (1*s.* 7 $^1/_2$*d.* to 2*s.* 5*d.*) per wagon carried, any distance."

The statistical information supplied by Mr. Reverdin is very interesting; it also confirms what I stated in my report, namely that since the Congress took up the question of transhipment, the use of carrying-trucks and carrying-wagons has become very extended. That proves that the companies think that this practice is economic and to be recommended. There is nothing like experience in order to solve questions of this kind.

The four-rail track is not applicable in a general way; but in special cases this solution is also very practicable and very useful.

The President. (In French.) — As nobody else wishes to speak in the general discussion, we now come to the conclusions.

Mr. de Burlet. (In French.) — These are the conclusions which I have the honour to submit for your approval :

" Experience has shown that transhipment from truck to truck by the level method does not constitute, for exchange traffic between lines of narrow-gauge and the main railroad, a too onerous charge in ordinary cases."

The President. (In German.) — We will take, with your approval, the clauses one after the other. If you have any objection, I will gladly hear it.

As nobody wishes to make any remarks, you agree to adopt the text of this first clause.

Mr. de Burlet. (In French.) — The next clause runs as follows :

" Nevertheless when, in certain special cases, or for certain goods, it is found indispensable to reduce the said charge, carrying-trucks or carrying-wagons, sunk or raised track arrangements, the use of tip-wagons and the partial equipment of the narrow-gauge line with a track of three or four rails, constitute solutions which experience has proved to be useful and practicable. "

I myself propose an amendment to this wording.

I had retained the three-rail track, as several administrations stated that they used them. Hence, I did not wish to condemn them. But as information unfavourable to the three-rail track has been given here, that item might be struck out. It was in a very conciliatory spirit that I had retained the three-rail track. We then should say : " ... of the narrow-gauge line with a track of four rails."

Mr. Campiglio. (In French.) — I ask that the original wording should be retained.

Mr. Jesser. (In German.) — Cases might arise, if the difference between the two gauges was small, when it would become technically impossible to lay four rails,

and in order to allow for such special cases, it would perhaps be better to let us retain the words : " ... three or..."

Mr. de Burlet. (In French.) — Under these conditions, I support the request of my honourable colleagues and propose that the original wording should be retained.

— Adopted.

Mr. de Burlet. (In French) — Two amendments have been brought forward. Mr. Campiglio proposes to add to the conclusions a clause 3 worded as follows :

" In investigating the question whether it is advisable to adopt the special installations mentioned in the preceding clause, consideration has to be given to the quantity and to the nature of the goods, to the distance they have to be carried and to the conditions relating to the exchange or hire of the rolling stock used for those goods (dues which have to be paid, time of utilization of the wagons, etc.)."

I allow myself to remark to my honourable friend Mr. Campiglio, that in my report, the last page of which contains a summary of it, consideration has already been paid to these different statements : the quantity and the nature of the traffic, the mileage, the conditions affecting the interchange of rolling stock, etc.

Each time I described a system of transhipment, I stated under what particular circumstances such and such a company applied it. Is it necessary to return to this in the conclusions, or does it suffice to mention the different special arrangements which have been adopted?

There is only one point which I have not mentioned in my report, and that is, the exchange and hire of rolling stock, and that I think is what is troubling Mr. Campiglio.

The honourable member states that the administration of the main railroad places the loaded wagons at the disposition of the narrow-gauge line, and that it allows the latter a certain time for the transhipment. Mr. Campiglio complains that that time is too short in Italy and he wishes to call the attention of the Congress to the somewhat Draconian regulations of the administration of the Italian State Railway. But it seems to me rather difficult to introduce this criticism in the conclusions.

Mr. G. Level, Société générale des chemins de fer économiques, France. (In French.) — It is a question of giving facilities.

Mr. Campiglio. (In French.) — We might say : " Independently of the conditions of quantity and of transport, attention has to be paid to the mileage of the goods and the conditions to be specified concerning the exchange or hire of rolling stock."

Mr. de Burlet. (In French.) — Strictly speaking there is neither exchange nor hire. Rolling stock is placed on the tranship sidings so as to be at the disposition of the narrow-gauge line for a certain length of time, that is all. It is, merely, a question of the time allowed for loading or unloading.

I repeat, it is difficult to introduce this at all accurately in the conclusions. One could say : " It is desirable that the great railroad companies should facilitate the tranship operations."

That is evidently what we all hope.

The President. (In French.) — Quite so; in a general manner.

A delegate. (In French.) — By increasing the time for which no charge is made.

Mr. de Burlet. (In French.) — We should then say :

" It is desirable that the main railroads should facilitate the transhipment operations by increasing as much as possible the time allowed therefor."

The President. (In French.) — I think that it is agreed that this wording should be adopted. (*Signs of approval.*)

Mr. de Burlet. (In French.) — The second amendment is by Mr. Charignon, who proposes that the following clause should be added to the conclusions :

" The great railroad companies are requested, with a view to the development of the traffic they get from narrow-gauge lines, to try to eliminate transhipment and to place at the disposal of the narrow-gauge feeder lines, rolling stock with adjustable wheels and axles, which can run on both gauges, as has conclusively been shown to be possible, in China."

I have some remarks to make about introducing this clause into our conclusions. In the first place, this system is comparatively new. How long has it been in use in China?

Mr. Charignon. (In French.) — For two years.

Mr. de Burlet. (In French.) — It is very little known in Europe. I do not know that a European company or even an American company has tried it. This system has not been described in any report or paper. Under these conditions, it appears to me to be risky to give any advice to companies, whether large or small, without having available a more complete report than the verbal communication we have had today.

Hence, I propose not to introduce in our conclusions this advice which it is proposed to give to large companies. This is always a very delicate matter, and I think we should go counter to the most elementary prudence if we now already took under our official patronage a system which has not yet proved its efficiency. I think that this would, moreover, be against the very wise rules adopted by the Congress.

As for me, I accordingly am unable to vote for this amendment; but as the communication made to us is of very great interest and it is not advisable that it should remain unnoticed, I propose to add to our conclusions this clause :

" The section has taken note, with interest, of the communication made as to the use, on a Chinese railway, of a truck with axles on which the wheels are adjustable."

Mr. Chassin. (In French.) — We might ask that the question should be brought before the next Congress.

Mr. de Burlet. (In French.) — That will form part of our conclusions and it will be for the Permanent Commission to place this question on the agenda, if it considers this to be advisable.

A delegate. (In French.) — But the section can express a desire about this subject.

Mr. Chassin. (In French.) — I propose the wording : " The section expresses the wish that this question should be placed on the agenda of the next session."

Mr. de Burlet. (In French.) — We have to propose a wording to the Congress, which it must consider. Therefore we must say : " The Congress..." and not : " The section..."

I accordingly propose to say :

" The Congress has taken note, with interest..."

Mr. G. Level. (In French.) — Gentlemen, I think you will be interested to hear that a very detailed technical description of this system has been published in the *Revue générale des chemins de fer* (1).

— The wording proposed by Mr. de Burlet is adopted.

Mr. de Burlet. (In French.) — Do we agree to adopt the following wording :

" It is desirable that the study of this system should be continued, and that information thereon should be brought before the next meeting of the Congress." (*Signs of approval.*)

These are accordingly the definite conclusions to be submitted to the general meeting for approval :

" Experience has shown that transhipment from truck to truck by the level method does not constitute, for exchange traffic between lines of narrow-gauge and the main railroad, a too onerous charge in ordinary cases. " Nevertheless when, in certain special cases, or for certain goods, it is found indispensable to reduce the said charge, carrying-trucks or carrying-wagons, sunk or raised track arrangements, the use of tip-wagons and the partial equipment of the narrow-gauge line with a track of three or four rails, constitute solutions which experience has proved to be useful and practicable. It is desirable that the main railroads should facilitate the transhipment operations by increasing as much as possible the time allowed therefor.

" The Congress has taken note, with interest, of the communication made as to the use, on a Chinese railway, of a truck with axles on which the wheels are adjustable. It is desirable that the study of this system should be continued, and that information thereon should be brought before the next meeting of the Congress."

— Adopted.

The President. (In French.) — Gentlemen, we have concluded our labours.

Mr. de Burlet. (In French.) — Gentlemen, I think we ought not to separate without expressing our sincere thanks and our best wishes to our distinguished president who has taken enormous trouble to study the very special questions included among our agenda and who has presided over our discussion with great skill and with perfect courtesy. He has undertaken a large additional amount of work in translating into German and into English the French speeches; he has thus largely contributed to the good progress of our labours. (*Long applause.*)

*

(1) 1909, December, p. 466. — A description of this system is also given in the *Génie civil*, 2 October 1909, and in the *Annales des ponts et chaussées*, 1909, November-December, p. 19.

The President. (In French.) — Gentlemen, I thank you. I have done all I could to conduct your labours as well as possible and I am happy that I have succeeded in doing this to your satisfaction.

Allow me to say, in my turn, a few words to those who prepared the work for our section. I do not think we can separate without expressing to Messrs. de Burlet, Jesser, Plocq and Quarré, our thanks and our cordial congratulations, for the very interesting and very instructive reports they have submitted to us. (*Loud applause.*)

DISCUSSION AT THE GENERAL MEETING

Meeting held on 15 July, 1910 (morning).

Mr. P. WEISSENBACH, president, in the chair.

General secretary : Mr. L. WEISSENBRUCH.

First assistant general secretary : Mr. MÜRSET.

Second assistant general secretary : Dr. A. BONZON.

Mr. von Ziffer, *vice-president of the 5th section*, read the

Report of the 5th section.

(See *Journal de la huitième session*, No. 8, p. 7.)

" Mr. de Burlet gave a summary of his report. The question of transhipment had already been formerly considered by the Congress, and no doubt it would again be considered in the future. It was connected, in fact, with the question of the gauge to be selected when it was proposed to build a secondary line. The narrow gauge presented, from the point of view of prime cost, an indisputable advantage over the standard gauge; but on the other hand, it made the transhipment of goods necessary. Was this disadvantage sufficiently serious to determine the selection of the standard gauge, even at the cost of a large expenditure? The answer would be in the negative in most of the cases; in fact on the one hand the passenger traffic, which generally yielded the more important part of the receipts, was not affected by it, and on the other as for goods, it represented an expenditure which in most cases hardly exceeded 15 to 25 centimes per ton (1·46*d.* to 2·44*d.* per English ton).

" The report contained details of six separate methods for the transhipment of goods between lines of different gauges :

" 1° Transhipment by hand, on tracks at the same level. This was the method which involved the fewest fixed installations;

" 2° Transhipment on sunk or raised tracks. This method was sometimes supplemented by the use of tip wagons or hopper-bottom wagons;

" 3° Transhipment by means of gantry cranes, chiefly used in the case of rough timber, machinery, blocks of stone, and

generally for goods consigned in the shape of indivisible lots of large weight;

" 4° The transfer, on suitably-arranged tracks, of the body of a wagon of the one gauge on to the underframe (with bogies) of one of the other gauge. This system, for which ordinary European rolling stock was not suitable, was in use in the United States;

" 5° Carrying-trucks and carrying-wagons. This system was applied on a large scale, particularly in Germany;

" 6° The transformation of the narrow-gauge line into a two-gauge line (track with three or with four rails).

" Mr. de Burlet gave a summary of a note he had received from Mr. Reverdin, of Geneva, on the subject of the carrying-trucks introduced, in 1896, on the lines of the " narrow-gauge " company, on the occasion of the Swiss national exhibition at Geneva. He noted that in 1909 he had conveyed, by means of eighteen pairs of trucks, more than 7,000 wagons containing 90,000 tons of goods between the Geneva-Cornavin station (Paris-Lyons-Mediterranean Railway) and sundry industrial sidings.

" Mr. de Burlet concluded with the statement that although the system of transhipment by hand, on tracks at the same level, was the system employed by far most frequently, one nevertheless had to recognize that in special cases carrying-trucks or carrying-wagons, sunk or raised tracks, the use of tip-wagons and of hopperbottom wagons, the transformation of the narrow-gauge line into a two-gauge line constituted solutions which had been successful in practice.

" Mr. Campiglio (*Italian local railway Union*) mentioned that in Italy the main lines only allowed a very short time for the return of any of their wagons handed to the narrow-gauge line for transhipment, and required payment of demurrage when this time was exceeded. According to Mr. Campiglio, this was injurious to the traffic, and he asked that his remark should be mentioned in the conclusions which were to be submitted to the general meeting.

" Several members of the meeting then interchanged views in order to ascertain whether, in their respective countries, the cost of transhipment was included in the tariffs, or was made the subject of a separate charge. The explanations exchanged showed that in most countries it was charged for separately; but the consignor or the consignee could avoid these charges by having the transhipment effected by his own employees, if he saw fit to do so. In British India, the charges in question were included in the tariff; the usual way of doing this was to increase the distance to be charged for by 3 miles (about 5 kilometres).

" Mr. du Beaufret (*Bône-Guelma Railway, Algiers*) gave some particulars about an important traffic of phosphates (300,000 tons per year). Several proposals for the installation of special devices in order to facilitate transhipment had been considered, but as yet no result had been arrived at.

" Mr. Charignon (*Chinese government*) informed the meeting that in China there was a narrow-gauge line, which brought a considerable amount of coal to the Pekin-Hankow main line; in order to avoid transhipment, wagons with axles on which

the wheels were adjustable were used. He gave some particulars about this system, and stated that this had now been in use for about two years, with satisfactory results.

" After some remarks by Messrs. CHASSIN (*French Southern Railway*), PLOCQ (*General French Light Railway Company*) and DE BURLET (*reporter*), as to the practical working of lines with three and with four rails, the section decided to submit the following conclusions to the general meeting."

The President. (In French.) — The following are the

DRAFT CONCLUSIONS

" Experience has shown that transhipment from truck to truck by the level method does not constitute, for exchange traffic between lines of narrow-gauge and the main railroad, a too onerous charge in ordinary cases.

" Nevertheless when, in certain special cases, or for certain goods, it is found indispensable to reduce the said charge, carrying-trucks or carrying-wagons, sunk or raised track arrangements, the use of tip-wagons and the partial equipment of the narrow-gauge line with a track of three or four rails, constitute solutions which experience has proved to be useful and practicable. It is desirable that the main railroads should facilitate the transhipment operations by increasing as much as possible the time allowed therefor.

" The Congress has taken note, with interest, of the communication made as to the use, on a Chinese railway, of a truck with axles on which the wheels are adjustable. It is desirable that the study of this system should be continued, and that information thereon should be brought before the next meeting of the Congress."

Mr. d'Abramson, Russian State Railway. (In French.) — The system of axles with adjustable wheels is also used in Russia with good results, on the South Western Railway, on the Vistula Railway and on the Warsaw-Vienna Railway. Hence it is a mistake to say that this system is only in use on a Chinese railway.

Mr. Blum, Prussian State Railway. (In German.) — It is also used in Germany.

Mr. von Ziffer. (In German.) — There is no mistake, or at least a delegate of the Chinese railways attended the meeting and talked about this system. I know that the Russian railways and the Austrian railways also have wagons of this kind; each of these countries has about 300 and there are also some in use on the new lines in Bukowina. The delegate of the Chinese railways did not give further details; he said that the invention was patented. I do not know what the difference between the two gauges in China is. If this system could be readily used on the Russian and Austrian lines, this is due to the fact that the difference is very small. But if there is a great difference in China, a wide gauge of 1·6 metres (5 ft. 3 in.) and a narrow gauge of 740 millimetres (2 ft. 5 $^{1}/_{8}$ in.), I do not understand how it is done. That is the reason why we did not mention the Russian wagons.

Mr. d'Abramson. (In German.) — Would it not be advisable to mention the other railways so as to avoid the same misun-

derstanding with those who do not know what the president of the 5th section has said?

Mr. von Ziffer. (In German.) — If you make a proposal to this effect, I do not think that it will be opposed by us.

Mr. Weissenbruch, *general secretary.* (In French.) — The last phrase might be modified as follows :

" It is desirable that the study of this system, which is also used in Russia, where it has given good results, should be continued..."

Mr. de Burlet, *reporter.* (In French.) — We could but reproduce and analyse the information brought before the section.

The list of questions relating to the subject of transhipment was sent to all the railways, including the Russian and the Austrian railways. None of them supplied any information about the use of such adjustable wheels and axles.

It was only during the discussion that our colleague, the delegate of the Chinese government, made a communication which we thought of interest and have mentioned in the conclusion.

It seems to me a matter of difficulty to state in the conclusions that the system of extensible axles has given good results in Russia, as no information to this effect was given to the 5th section, nor was any discussed.

I, however, see no disadvantage in adding to the proposed conclusions and mentioning that the system is also used in Russia; but we must refrain from saying that it has given favourable results.

Mr. d'Abramson. (In French.) — I agree.

Mr. Weissenbruch. (In French.) — We might say : " It is desirable that the study of this system, which has received applications in Russia and in Austria..."

Mr. Blum. (In French.) — And in Germany.

Mr. Weissenbruch. (In French.) — Or still better : " ... which has also received applications in other countries..."

Mr. d'Abramson. (In French.) — And between brackets put : " Germany, Austria, Russia." (*Approval.*)

The President. (In French.) — These are then the

FINAL CONCLUSIONS.

" Experience has shown that transhipment from truck to truck by the level method does not constitute, for exchange traffic between lines of narrow-gauge and the main railroad, a too onerous charge in ordinary cases.

" Nevertheless when, in certain special cases, or for certain goods, it is found indispensable to reduce the said charge, carrying-trucks or carrying-wagons, sunk or raised track arrangements, the use of tip-wagons and the partial equipment of the narrow-gauge line with a track of three or four rails, constitute solutions which experience has proved to be useful and practicable. It is desirable that the main railroads should facilitate the tranship operations by increasing as much as possible the time allowed therefor.

" The Congress has taken note, with interest, of the communication made as

" to the use, on a Chinese railway, of a " truck with axles on which the wheels " are adjustable. It is desirable that the " study of this system which has also " received applications in other countries " (Germany, Austria, Russia, etc.) should " be continued, and that information " thereon should be brought before the " next meeting of the Congress."

— These conclusions were adopted by the general meeting.

VARIOUS MOTIONS

I — MOTION

RELATING TO THE DRAFTING OF THE LIST OF QUESTIONS OF THE NINTH SESSION

3rd SECTION : WORKING

[656 .225.2]

UTILITY OF STUDYING THE QUESTION

OF

FREIGHT-CAR INTERCHANGE AND DEMURRAGE

A. *Regulations for the interchange use of freight cars between railroads and penalties for delays and misuse of freight cars by railroads.*

B. *Regulations to prevent delays and misuse of freight cars by shippers and consignees.*

Reporter :

Mr. W. F. Allen, general secretary and treasurer, American Railway Association.

*

UTILITY OF STUDYING THE QUESTION

OF

FREIGHT-CAR INTERCHANGE AND DEMURRAGE

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[656 .223.2]

NOTE

ON THE UTILITY OF STUDYING THE QUESTION OF FREIGHT CAR INTERCHANGE AND DEMURRAGE,

By W. F. ALLEN,

GENERAL SECRETARY OF THE AMERICAN RAILWAY ASSOCIATION.

INTERCHANGE OF FREIGHT CARS AND DEMURRAGE.

General.

In considering the subject of " freight car interchange and demurrage ", as presented in this report, it should be stated in the first place, that it was included in the programme of the Congress at the request of the American members of the International Commission, and that the questions as formulated were drawn up especially for the purpose of eliciting information of value in the solution of the intricate and very important car service problem encountered in North America.

To the members of the Permanent International Commission who authorized the issuance of the circular, and to those officials who have so courteously furnished the very complete information sent in reply, the thanks of the American members of the Congress are due and are most cordially tendered.

The reports received are from administrations which operate in all about 430,000 miles of railway and possess about 3,800,000 freight cars. Of these 250,000 miles and 2,200,000 freight cars are in North America and about 182,000 miles and 1,600,000 cars elsewhere.

It is an interesting fact to note that the number of freight cars per mile of road, taken as a whole, is about the same on the North American railways as in the rest of the World, that is, a little less than nine cars to the mile. In a few instances, the equipment is much greater, and in some cases as high as thirty cars to the mile. These figures of cars and miles were not obtained directly from the reports but from other fairly reliable sources.

The question presented in North America is that of evolving the most efficient method of handling on a uniform basis 2,200,000 freight cars, that move freely over 250,000 miles of railways and serve over 80,000 communities many of which have

numerous substations The extent of the territory traversed by these railways is about 3,000 miles east and west and an equal distance north and south.

These 2,200,000 cars have over nine hundred different owners, although about 80 per cent of them belong to fifty-six companies. From 25 to 50 per cent of this equipment is constantly in use upon the lines of roads other than those to whom the cars belong From these figures the magnitude and complexity of the situation in North America may be understood.

The conditions as compared with those on the European Continent are mitigated however by the fact that there are but two lines of custom houses to be passed (between Canada and Mexico respectively and the United States), that the same language is spoken on both sides of one of these lines and that all of the governments are disposed to facilitate commercial intercourse without unnecessary obstruction.

One detail closely related to this general topic — that of the best method of distributing freight cars locally upon the lines of each company — has not been included in this report. The conclusion on that subject reached at the fourth session of the International Railway Congress, held at St. Petersburg, in 1892, was as follows :

" The distribution of rolling stock is made generally under conditions justified by the geographical characteristics of each railway system and appropriate to the nature of its current of commercial traffic."

No better statement can be made today, and no generalization of the methods employed, however interesting, would be of much practical value since each system must use the method best adapted to its own local requirements. However, those who may wish to study this phase of the subject, will find in the excellent paper of Mr. Richter, the distinguished reporter to the fourth session of the Congress, a very complete statement in detail of the practices in force on European railways in 1892. It will be found in the third volume of the Proceedings of that session. It does not appear that many important changes have been made in these practices since 1892.

Before proceeding to the consideration in detail of the subjects of this report, the following general statement should be noted.

The responses exhibit the fact that the same problems, more or less troublesome, exist everywhere. In some of them, information is given which is not strictly of the nature of a reply to the questions asked ; but when such information relates to the general subject and is of an interesting character it has been included. It is evident, in a few instances, that the questions have been misinterpreted and in some, the reply to one question has been included in the answer to another. An attempt has been made to note all such cases by cross references.

Ab Initio every freight car may be assumed to be loaded in a location where the track upon which it stands is the property of the company which also owns the car. In passing beyond the terminus of that road to the lines of another road, whether of the same country or not, the vehicle becomes technically a " foreign car " and the

company which is then in control of its movement is under certain obligations to its owners for its use, its physical care, and for its prompt return either loaded or unloaded. The rule everywhere is that a foreign car must be kept in general repair by the company which holds it, certain work of a specified character being billed against the owner.

The agreements under which foreign cars are taken care of physically are not, however, within the scope of this report, which is confined to the subject of their interchange use and undue detention and the charges accruing therefrom. For the purpose of distinguishing them, these charges are herein named as " car hire " and " demurrage ".

By " car hire " is meant the amount which the administration using a car pays to the owner for its use, whether the payment is based upon the distance travelled, or is so much a day, or both. Included under this head is the penalty charge exacted for the undue detention of a car upon its lines by a foreign road and similar charges imposed when the car is missent or misrouted on its return journey.

By " demurrage " is meant the amount which the railroad holding the car, whether its owner or not, exacts from the shipper or consignee for its undue detention, when it has been placed for loading or unloading, this charge covering the occupancy of the tracks as well as the use of the vehicle. Money collected for demurrage accrues to the benefit of the owner of the track, who in turn, in the case of a foreign car, settles with its owner for its use.

The tendency of the shipper and of the consignee to take an unnecessary amount of time to load or to unload the car, si everywhere recognized as an evil which if permitted to go unchecked would greatly lessen the efficiency of railway operation.

The word " demurrage " has been employed in some of the replies to the circular of inquiry in referring to detentions caused by railroad companies as well as by customers; but it has not been possible to so use it in this report without confusion. Some liberties have therefore been necessarily taken with the exact wording of the reports received, for which the writer wishes to duly apologize.

The summaries of the replies refer to other countries than North America except where otherwise stated.

Freight car interchange.

It is evident from the replies received that in all parts of the world that railway authorities have decided it to be essential to the prompt and economical transportation of freight by rail, that its passage beyond the termini of roads and the boundary lines of countries, must not make necessary the unloading and reloading of freight cars, but that the contents of fully loaded cars [1] must be transported from their

[1] Whenever the word " car " is used in this report it refers to vehicles used for the transportation of freight (goods, merchandise, coal, etc.) and not to passenger carriages.

points of origin to destination without break of bulk. Shipments of less than car load lots may or may not be economically reloaded, depending upon the quantity and character of the lading and its proportion to the full loading capacity of the car. The regulations as to what this proportion should be vary from 20 to 33, 40 and 50 per cent of the carrying capacity of the car. Generally a car is considered as if it were sufficiently loaded when payment has been made for the required proportion whether the lading actually occupies the space called for or weighs the amount stated. The minimum lading permitted varies sometimes with the distance the car is to be transported.

From the standpoint of the shipper and to a certain extent of a railway station agent, a car is merely a vehicle of transportation without regard to its ownership, and the tendency is to place a waiting load in an empty car no matter in what direction the movement is to be made.

If all cars were of the same ownership, the direction of their loaded movements would of course be a matter of indifference, but the ownership of cars by separate companies or administrations presents another phase of the question. These companies desire to retain the cars upon their own lines in order that they may earn the interest on their cost together with the interest on the considerable investment in other property which is part of their freight equipment. When the car is not available the earning capacity of all of this property is dormant.

The general method of equalizing these conditions is to require payment to be made to the owner for the use of the car when it is employed upon another system.

Two factors are commonly recognized as entering properly into the rate fixed for car hire, viz : the distance the hired car is transported and the length of time it is used. For the purposes of this report the term " mileage " is used in referring to the distance charge and the term " per diem " for the daily charge.

In some calculations of mileage, the car is considered as the unit without regard to its size or loading capacity. In others the unit is the axle so that a four axle car earns twice as much rental per mile run as a two axle car, and in still others the rate varies with the tonnage capacity. Sometimes the mileage rate is graduated, as in Great Britain, where the rate per mile for distances of over 278 miles is less than one half that charged for distances of 58 miles and under. In South America, the mileage rate varies according to the loading capacity of the car and no per diem rate is exacted. In North America, no mileage is paid for the use of the ordinary freight cars belonging to railroad companies, but it is paid on privately owned cars.

The unit of time upon which in general, the per diem rate is based, is the full period of twenty four hours; but in some parts of the continent of Europe, the unit is a period of twelve hours, and a few instances a rate per hour is charged. In East India and also in South Africa, the charge for time is by the hour and the rate is fixed at a certain price per ton on the loading capacity of the car, which capacity varies from twelve to thirty five tons avoirdupois.

In North America, the record is kept by dates : that is to say, the per diem rate for

the entire following period of twenty four hours is charged against the road which holds the car at midnight. This rate is so much per day without any mileage charge and without regard to the loading capacity, which varies from 20 to 50 net tons. Formerly the uniform charge was six tenths of a cent per mile run. A few of the larger lines experimented in 1888 and in 1893-94, with what was called a " mixed per diem " the rate in 1893-94 being one half of a cent per mile, plus 6 cents per day; but this experiment was not followed by the other lines and was abandoned after a few months trial. In 1902 a " straight per diem " was adopted by all the lines, and that method has been in use for the past seven years at various rates of charge.

While the rates reported affect all cars alike for the greater part of the freight equipment of the World yet certain classes, such as refrigerator cars, are in service upon many of the lines and receive exceptional treatment. These classes form, however but a small proportion of the total equipment and need not be considered in any general review of the subject. Statements of the details of these special arrangements will be found in the text of some of the accompanying responses. The regulations for the interchange service of passenger cars which were given in some of the replies are not generally reported herewith, as they are foreign to the subject under consideration, but in a few instances, they are closely interwoven with the information concerning freight cars and have been noted.

The reports as to the methods of these operations on the railways of Germany, were made prior to the formation of the pooling agreement which took effect on 1 April, 1909. They are now, consequently, modified by the terms of that agreement a copy of which is presented as a supplement to this report. These old regulations are of special interest because they show the arrangements superseded by the pooling agreement and which presumably were considered the best known methods while they were in force.

The Russian system of interchange of car for car, in countries where the traffic is of a nature that permits equalization of movement, appears to have ideal advantages second probably only to those of a practicable pool. Whether it will be possible to maintain this method of working satisfactorily in case an extensive system of branch railroads should be developed as feeders of the Trans-Siberian line and at its extreme eastern terminii, is perhaps an open question. The Russian tracks being of a different gauge from those of the rest of Europe, the situation is not complicated by the presence of foreign cars; although some experimental arrangements for a limited interchange movement of these cars are now being tried.

An equalizing method of interchange is also provided for in the Rules and Regulations of the Indian Railway Conference Association.

The agreement between the Southern Railway of France and the Paris-Orleans Railway disregards differences on balances unless in excess of three hundred cars, and a similar agreement is in force in the Italian-French traffic via Modena-Vingtimille.

In South Africa, the cars of the Cape Government Rys. and those of the Central South African Ry. are pooled for through traffic each furnishing a prescribed number of vehicles, no car hire being levied.

Similar arrangements exist in North America between some directly connecting lines of different ownership, but these are generally confined to cars in such traffic as that of coal, ore, etc., having a load in one direction only.

The revenue which the owner of the car receives from its user is somewhat increased by the collection of penalties charged for its misuse. For instance in North America in 1906, the per diem rate was 25 cents, but a penalty rate of an additional 75 cents per day was exacted if the car remained upon a road for more than thirty days, provided a notice that it was being unduly detained had been served on the holder of the car at the expiration of twenty days. The additional payments made under this plan amounted on the average to about 2 $^1/_2$ cents per day.

The penalty charges however are not made anywhere primarily for the purpose of increasing the revenue of the owner of the car. In some cases it is true they serve to reimburse the owner for the detention or misuse of the car, but in others they are designed by their severity to prevent the offence being committed. The charges exacted are from 25 cents to 5 dollars a day, the several rates not being imposed for the same reason, but for various offences against what is considered proper handling. These offences however, are of two general characters, — the failure to promptly return the car to its owner after unloading, and the misrouting of the car for the purpose of obtaining a load, in which traffic the owner of the car does not participate.

The return of a car empty over a different route from the one used on the outbound journey is sometimes penalized by requiring the erring road to pay to the road which hauls the car whatever the latter road must pay the owner of the vehicle for ordinary car hire plus an amount which varies from double to six times this car hire. The road which originates the diversion, or wrong sending, is responsible for the charges which accrue. The owner of the diverted car collects the charges from the user, but the latter inturn collects from the erring road, which is required to report its own delinquencies.

The custom of allotting a certain period of time for the journey of a car and charging a per diem or penalty rate for its detention beyond the limit allowed is in quite general use. Under the conditions which exist in North America however, an arrangement of this character is regarded as impracticable and it has never been attempted.

Generally, the penalty charge is fixed at a certain sum per day, but in other instances there is a heavy mileage charge added. The penalty rate is fixed in South Africa on the basis of so much per truck per hour and in East India at so much per ton per hour. The penalty rate for undue detention is very often, although not always, increased as time progresses. Instead of a penalty for bad conduct, a reward for good service is sometimes provided by an allowance of a certain free time, or of a reduced charge, for the return of a car within specified periods which

are graduated according to the length of the journey. This same method is also occasionally made use of to secure a return load, the per diem charge being cancelled when a car is returned loaded, but exacted if it is returned empty.

The penalty charges for diversion and wrong sending are often reckoned on a mileage and per diem basis for each car without regard to its size, but in some instances the penalty rate increases with the capacity so that while upon an ordinary car the rate is 75 cents a day, upon one of the heaviest tonnage capacity the rate is 5 dollars per day.

There is a penalty charge of one dollar on some roads payable to a car owner when the lading of the cars is transferred at the junction point in order to enable the receiving road to make better use of its own rolling stock. On the Italian roads, the penalty for breaking the established car service rules is a fine equal to ten times the ordinary mileage charge.

It is manifestly impossible to draw accurate conclusions as to the comparative economic efficiency of the freight cars of one or another country from an examination of the relation which the rate per day that is paid for their use in interchange car service bears to the cost of the cars, without taking other facts into consideration. The function of the freight car as a vehicle of transportation is to move a load from one point to another. For this movement, the owner of the load pays a certain sum, but this amount cannot all be credited to the car as its earnings, as is shown hereinafter. Yet there is a relation between the car and the freight earnings. For instance, if an isolated road has one million dollars of annual earnings from freight traffic and possesses one thousand cars, then each car earns on an average one thousand dollars per annum (1). Should one hundred of these cars be destroyed or be otherwise unavailable, the remaining nine hundred, with equal individual movement and the same freight rates, could earn only nine hundred thousand dollars and the business of the road would decrease one hundred thousand dollars. If, on the other hand, one hundred additional cars should be provided, without any increase in the volume of business passing over the line, then either these additional cars would be idle or the average earnings per car would be decreased and would be about 909 dollars per annum, or the quotient of 1 million dollars divided by eleven hundred.

The factors which affect the sources from which freight traffic is derived, are extremely various and often so remote that it is impossible for railway managers to anticipate with even approximate exactness what number of cars will be required for the business of the coming season. For instance in North America, the demand for cars was so greatly in excess of the supply in the summer of 1907 that about two hundred thousand new cars in addition to the two millions then on hand were ordered to be delivered in the latter part of the year. But certain influences had

(1) There were about 1,800,000 freight cars in actual service in the United States and the total earnings from traffic were reported as 1,823,651,998 dollars for the fiscal year ending 30 June 1907.

been for some time sapping the sources from which the business originated and suddenly in the latter part of November 1907 the effect of this culminated. There was a shortage reported of about ninety-one thousand cars on 1 November 1907. This shortage rapidly disappeared and ten weeks later, a surplus of three hundred thousand cars was reported, reaching a maximum of four hundred and thirteen thousand at the end of April 1908. So without the additional equipment provided in 1907, there would have been a surplus of from one hundred and fifty thousand to over two hundred and ten thousand cars, during a large part of 1908.

It cannot be assumed from these statements that the number of cars in actual service in North America was the difference between the figures given and the total equipment of 2,200,000, because of the large number of bad order cars on hand. In normal times, this number is about one hundred thousand, but it is certain that it exceeded two hundred thousand for a considerable part of 1908.

Doubtless similar variations in the demand for cars have everywhere been experienced, although perhaps not often so violent as in the case noted. But it may be deduced that the measure of the value of a freight car is not governed solely by the volume of the business, and that while this factor of the problem is important, there are other items which must also be considered.

In the case above cited, if the freight rates should be suddenly doubled without diminution of traffic the average earnings per car would be also doubled without any increase in the volume of business. The gross earnings of the car are therefore affected by the schedule of freight rates as well as by the volume of traffic.

If there are two connecting roads, one with high rates and a large traffic and the other with low rates and small traffic, the value of car as a revenue producer may be much more on the first road than the second road can afford to pay. Yet it may be possible that the stronger road could with advantage build additional cars for interchange with the other road if the latter could afford to pay enough for their use to cover the interest on their cost, plus an additional sum sufficient to cover maintenance and renewal, provided that cars were to be placed in traffic which would require them to be transported for part of their run over the tracks of their owner.

Cars so handled will not be as profitable to their owners as those which remain altogether upon their own lines, but will nevertheless yield some profit above the bare cost of of ownership. If, however, cars are engaged in any traffic in which their owners have no share a larger compensation may be justly demanded for their use from the administration in whose service they are engaged. Conditions vary so greatly in different countries and on different roads in the same country as to make it difficult to determine exactly what the possession of a freight car yields to its user. There are however to be found in the report of the United States Interstate Commerce Commission of the Statistics of Railways for the year ending 30 June 1907, som figures from which certain deductions may be drawn for that country.

The total capitalization of the railways of the United States on the above named date was 16,082,146,683 dollars. The earnings from freight traffic were about

seventy per cent of the total operating revenues and we may assume that seventy per cent of the total capital was that upon which the freight traffic was based. Those figures in round numbers are 11,256,000,000 dollars.

There were on the average about 1,800,000 freight cars in service in the United States during the year under consideration. Each car therefore represented 6,253 dollars capital investment for which it was the vehicle that earned whatever returns were secured. The average investment in a freight car in the United States was 722 dollars in 1907. This investment was incapable of producing any revenue without the aid of that part of the railway plant which is represented by the remaining portion (5,531 dollars) of the amount of capital investment allotted to the freight department.

The gross earnings from freight for the year were about one thousand dollars a car. The operating expenses were 67 per cent and the net revenue from each car figures therefore at 330 dollars for the year. Annual earnings of 330 dollars are equivalent to 90.4 cents per day, but no one would think of paying such an amount for car hire unless the conditions were very unusual.

These calculations are interesting, but as a matter of fact, such exact adjustments of rolling stock and other equipment do not exist in practice. The year ending June 30, 1907 was one of exceptional activity in business in the United States.

As a general rule, the arrangements between roads are reciprocal, that is, each pays the same per diem rate to the other for the use of its cars. In exceptional instances, however, when one road has a longer haul than the other a difference is made in the per diem charge to cover the expense of maintenance on account of the greater mileage run. Again in most cases the same per diem or mileage rate is in force throughout the year, but in one instance where the traffic is light for eight months and heavy for four months, the charge during the latter period is from four to five times as great as during the former.

Still another method is being experimented with, namely- an allowance of ten days free with a charge of 60 cents for the eleventh day and 1.35 dollars for each day thereafter.

In France, the fact that different conditions require different treatment is generally recognized and consequently each company makes with its neighbours such arrangements for the payment of car hire as may mutually be agreed upon, except that the State Railway pays and receives a mileage rate in all cases.

One problem to be determined is how much the owner of the car should receive from the user for its use, the question being complicated by the fact that when traffic is large the owner of the car loses heavily in freight earnings from its absence, while in times of light traffic he will often be glad to receive an amount barely covering the interest on the car and its upkeep, rather than to have it lying idle and deteriorating on a side track.

From the replies given, it appears that the capacity of freight cars varies from the little five ton van of England to the massive sixty ton car of Bavaria and North

America. Outside of North America there are very few cars of over 35 to 40 tons capacity. In North America there are not less than three hundred thousand cars having a capacity of fifty or more net tons.

A comparison of the cost of the various classes of freight cars is interesting. The lowest value given for any car is 310 dollars and the highest for an ordinary freight car 2,727 dollars. Values of special freight cars are reported as high as 5,655 dollars.

The figures are hardly comparable for any useful purpose as they depend upon cost of material, cost of labor, character of the structure and in some cases upon the charge for the transportation of the cars from their place of manufacture. All of these costs vary from one cause or another in the different countries and parts of the World. The values are stated in the currency of the country in the original responses.

The question of whether the best method of handling the interchange of freight cars either in the interest of efficient transportation, or for the protection of their owners, is by pooling the cars, or by compelling their proper handling and return by means of sharply enforced penalties for misuse, must be regarded as an open one.

The common use of cars without regard to ownership, appears primarily as if it would facilitate transportation, but without careful intelligent supervision and direction, cars may be found grouped in one section of the country when needed in a far distant section. The larger the number of cars and the wider the extent of the country, the greater will be the task of securing equitable distribution without excess empty mileage to restore the equilibrium. Yet it is certain that the movement of empty cars is increased by the enforcement of the prompt return of the cars to their owners by means of heavy penalties for diversion.

Perhaps the adoption of one or the other method depends upon the conditions which surround the traffic and these may differ in various countries or in different parts of the same country.

The ideal system would of course be one that would avoid all unnecessary empty mileage and have a sufficient supply of cars always on hand when needed for loading, but that would require the exercise of almost omniscience and omnipotence; omniscience because the unexpessed wants of the thousands of shippers for tomorrow and next day must be known, and omnipotence because the disobedience or disregard of orders may disarrange or destroy the proper working of the best devised plans.

The following general conclusion, however, appears to be based upon sound principles.

That when the nature of the traffic, the condition of the equipment and the relations between the administrations are such as to permit the pooling of freight cars, such practice presents advantages, provided the daily allotment of cars to the systems when they are needed is controlled by an impartial and efficient central office so organized as to be able to obtain sufficiently complete information as to the relative importance of demands for equipment, and to enforce its own orders. Each administration, party to the pool, should be entitled to have generally upon its line the

number of cars which it has contributed to the pool; but this provision should be disregarded when in the opinion of the central office the demand for cars elsewhere is more important in order to facilitate prompt movement. The distribution of the cars available on each system to the stations requiring them should be left in the hands of the local administrations.

Demurrage.

The difficult problem presented in North America with respect to uniform rules for the interchange use of freight cars between railway companies has been already mentioned. A still more difficult problem is presented with regard to the demurrage rules, for in addition to the vastness of the field to be covered there is added this further complication: There are 46 State Governments besides the General Government in the United States, and those of Canada and Mexico, and all of these forty nine powers claim the authority to intervene and to regulate the charges and provisions concerning demurrage by the passage of laws which according to the individual views of the legislators will prevent unjust discriminations or promote the interests of their citizens. Such political regulations are apt to be more or less affected by the opinions of those who are not wiser, but considered to be more numerous at the local polls. Besides this, the railway companies themselves are not entirely united in their views on the subject, partly owing to the different laws under which they must operate, but largely because of concessions that have been wrung from them in the past by shippers and consignees under the threat of the withdrawal of patronage in the face of severe competition. These concessions have become so ingrained in the methods of the railways, and of the business men of the different sections of the country, as to make an attempt to remedy all of the present evils a task of no small magnitude.

A further complication, which exists to some extent elsewhere arises from the fact that there are over 100,000 private freight cars in service on the North American railways, that is cars that are not owned by the railway companies, but by other corporations, (generally manufacturers), firms, or individuals. Many of the owners of these cars also own side tracks and in some cases, terminal roads of considerable extent. The status of these private cars when upon the tracks of their owners, or upon the tracks of other owners of private cars, has been a subject of much controversy. Some of these private cars are used not only in transporting the products of their owners but also to a considerable extent in general traffic.

The difficulty that is found everywhere, that freight cars are very variable units having numerous classes and kinds is also present.

In discussing the question of the interchange of freight cars, the value of the car to its owner and the result of its undue withdrawal from service by reason of delays caused by the action of the railways themselves was considered. Everything there said with regard to the damage suffered by the loss of the use of the cars

applies with equal force when there is unnecessary delay on the part of a shipper or a consignee. There are hundreds of thousands of shippers and consignees, and a very slight period of unnecessary detention of the cars on the part of a considerable number of these parties may be sufficient in the aggregate to seriously cripple the movment of the commerce of a continent.

Both shippers and consignees are entitled to sufficient time to load and unload their freight, but it is clearly in the interest of efficient transportation, that the time employed by the most active of them should be the measure to which all others should be required to conform, and that on behalf of the common weal, the slow moving, badly equipped, or idolent shipper, or consignee, should not be permitted to use any excess time beyond the minimum, or if he does he should be required to pay a compensating penalty.

The following summary of the prominent features of the demurrage regulations is for countries other than North America.

The units upon which the demurrage charges are generally based are, as in the case of the charges for car hire, the day of twenty-four hours, and the car, without regard to its loading capacity. Yet there are several sliding scales of prices. The rates of increase in these scales are sometimes based upon time, as for instance where the rate is 50 cents for the first day detention, while it is 1 dollar on and after the third day. In other cases the rate of charge is increased with the capacity of the car, so that for 1 of 12 tons capacity the rate is 1·60 dollar per day, while for a 25 tons car the rate is 3 dollars and 20 cents a day.

Tank cars are generally considered as in a class by themselves and subject to a special rate of demurrage. All classes of cars is most countries are subject to demurrage charges. In some cases when no demurrage is charged for the car itself, a charge is made for the occupancy of the track. Exception is sometimes made in favour of private cars on private tracks, and in others on private cars when on the tracks of their owners only. Charges for detention of cars containing perishable lading are included sometimes under the head of demurrage.

The free time allowed before the demurrage charge begins to accrue is generally from twelve to twenty-four hours, but this may be shortened in case of the accumulation of freight, sometimes as much as one third. In other cases, but eight working hours are allowed with two hours extra where customs examinations are made. Sometimes all the working hours of the day following the receipt of the notice to the consignee of the arrival of the shipment are free. Again, cars placed before 9 a. m., must be unloaded the same day and if placed after that hour they must be unloaded before 12 o'clock the following day. In England, the free time must be " clear days ".

Occasionally the capacity of the car is considered, as in Russia where six hours for loading and twelve hours for unloading is allowed on small cars and double this time on large cars.

In South Africa, twenty-four hours are allowed for unloading and twelve for load-

ing. Tank cars are in some cases allowed three days and coal and coke cars thirty-six hours.

On Sundays and Holidays throughout the World, no demurrage charges accrue.

The distance the consignee lives from a station is sometimes taken into account and an additional allowance of time made for it, but generally this is not considered as the consignee is supposed to know that a shipment for him is about to arrive and it is expected that he will be prepared to receive it.

The principle which governs the method of computing the free time allowed before the demurrage charges accrue is based upon the idea that the consignor or consignee has the car in his possession as soon as it has been placed for loading or unloading on a public track, and that the time granted is sufficient for the required work. Delays caused by custom house or excise regulations are allowed for when the detention is not caused by the fault of the shipper or consignee. When the time is restricted to less than a full day the free time is reckoned from some specified and designated hour.

The time of the delivery of a notice to the consignee is reckoned from the hour when the car is actually or constructively placed in his possession. If the notice is sent by mail, a certain time is allowed for its delivery, sometimes not over three hours. The placarding at a designated place in the station of the notice of the arrival of a shipment, is in some cases considered sufficient notice to the consignee. Detentions plainly caused by tempests, floods or other acts of Providence, are not counted in reckoning the demurrage charges.

The hour of placing a car on a private side track is taken as the commencement of the free time, and a shorter time is generally allowed than in the case of a public siding.

Special notice in advance that demurrage will accrue after a certain hour is not generally considered necessary, but it is quite customary to send such notices as a matter of convenience, and to facilitate the work of unloading, even when not required.

Notifications when required may be sent by messenger, telephone, telegraph message or by mail; in the latter case on printed forms. The notices give information as to the time of the arrival of the consignment, and are sometimes, but not generally supplemented by a second notice as above mentioned. The rules as to the demurrage charges are frequently printed on the form of the notice. The non-receipt of the notice is not accepted as an excuse in India and in Russia. In Australia and some parts of Europe, notices are not required. Sometimes the only notice give is in the form of a statement on the bill of lading.

In England, the fact is made prominent that cars detained for goods to be unloaded are held by the companies as in warehouses and not as carriers.

A deposit is sometimes demanded, to cover possible demurrage chorges, at the time a car is placed for loading or unloading. If a car is ordered and not used the deposit is forfeited to the railway company.

When a car is promised to a shipper, a penalty may be collected by him if the car is not furnished. But where such regulations exist, no promise is permitted to

be made to a shipper unless the car ordered is actually at the station. Where a promise is made in advance it may be cancelled without penalty upon notice to the shipper given a certain prescribed time before the hour the car was to be placed.

Requests from shippers for cars are considered as information and are accepted only within the capacity of the service.

The delivery of cars ordered to be placed on private sidings is generally governed by special contract.

The ordinary places for loading and unloading are supposed to known to both shippers and consignees.

The inability of consignees to receive freight does not exempt them from demurrage and cars may be unloaded and the goods stored at the cost of shippers or consignees.

The refunding of demurrage collected is not generally favored and where allowed the amount of such restitution is not more than half the sum remaining after deducting the expenses which the railway has incurred on account of the detention of the car. Applications for this restitution are treated on their merits and granted only in exceptionably favorable cases, when the railroad was at fault or when from natural causes (floods, snow-drifts, etc.), unloading was impossible or dangerous, or the freight might have been damaged if moved. All applications for refunding demurrage are refused in times of car shortage.

It should not be understood that all of the demurrage regulations above noted are to be found in the replies of any single administration. Yet it must be conceded that they all possess merit and are calculated to facilitate promptness and efficiency in transportation. Where any of them cannot be enforced, it is not because they ought not to be, but on account of some reason of a commercial nature. These reasons are occasionally sound, but often are merely urged in the selfish interest of a particular customer, or class of customers, by whom concessions are sought which can only be granted at the expense of the rest of the commercial world.

The Demurrage Rules of the American Railway Association, which are used in North America, are given in full in the appendix to this report. They are recommendatory in their character.

The following principles, which should govern the formulation of demurrage rules, are presented as the conclusions of this part of the report :

1° The prompt release of loaded cars and the prompt loading of empty cars are essential to the efficient operation of railways in the interest of both shippers and carriers;

2° The undue detention of cars by consignors or consignees prevents the distribution of empty cars to other patrons and causes car shortages in times when business is prosperous;

3° The service to be rendered by the carriers in consideration of the freight charges does not include the use of the cars for storage purposes by the consignee;

4° The occupancy of cars by consignors or consignees is of value to them and a cause of expense to the railroads;

5° The only method of preventing the undue detention of cars by consignors or consignees is by the imposition of charges for their occupancy and that of the tracks upon which they stand, and these charges are fully justified by the conditions as stated above in 1°, 2°, 3° and 4°;

6° The free time allowed for loading and unloading should not be greater than the time necessary for those purposes when adequate facilities are employed and due diligence exercised by the consignor or consignee;

7° The amount of the demurrage charge should be larger than the storage charge for the use of a warehouse for the same period.

The following table shows the amount charged for Care Hire for cars of various costs, their average loading capacity, the free time allowed for loading and unloading and the Demurrage charges. In translating the mileage rates into per diem rates it was necessary to assume an average daily movement and this, when not specified in the regulations, was taken as 25 miles (40 kilometres) that having been found by the statistics of the Committee on Car Service of the American Railway Association to be about the average in that country (1). Thus a rate of one and a quarter centimes per kilometre makes fifty centimes (10 cents) per day which added to the per diem rate of 25 cents makes a total " car hire " of 35 cents per day.

Summary statement of charges for car hire and demurrage.

Car hire rate per day U. S. currency.	Cost of cars (1).	Loading capacity metric tons.	Free time allowed for		Demurrage charges per day U. S. currency.
			loading hours.	unloading hours.	
15 cents.	750 to 980 dollars.	10 to 11	24	24	2 to 2·40 dollars.
22 1/2 —	325 to 925 —	12 to 16	24	24 to 36	24 cents to 1.15 dollars.
25 —	466 to 1,069 —	18 to 45	48	48	1 dollar.
25 to 60 —	870 to 1,450 —	...	24	24 to 36	24 cents to 1 dollar.
28 —	435 to 700 —	11 to 14	8	8	1·20 dollars.
35 —	650 to 1,100 —	5 to 25	12 to 24	12 to 24	50 cents to 1 dollar.
37 1/2 —	310 to 2,550 —	9 to 37	24 to 48	48	(2)
45 —	723	13	24 to 48	24 to 48	60 cents to 1 dollar.
30 to 60 —	325 to 1,060 —	5 to 40	48	48	75 cents to 5 dollars.
65 —	400 to 900 —	13 to 35	24	24	1 cent per ton.

(1) These prices are for cars in general service. There are also special cars which vary in cost from 975 to 5,655 dollars for which the ordinary rates of car hire and demurrage apply unless otherwise noted in the detailed responses.

(2) 25 cents for each 1,000 kilograms of maximum load of car.

(1) This daily movement of 25 miles is the average for all cars in service. On the other hand, a freight car which starts from New York is delivered at Chicago in from three to five days, the distance being from 908 to 1,047 miles according to the route taken.

For comparisons as to relative efficiency these figures are not exact, but for the purpose for which this report is compiled they are at least interesting without further refinements. For those refinements a knowledge of the comparative freight rates and of the volume of traffic would be necessary. That would involve an almost impossible compilation and then would be practicably incapable of statement in a concrete form. It is evident however, that other factors besides the cost of the car and its tonnage capacity have affected the car hire and demurrage rates.

All the railways of Continental Europe, except Russia, are also in the International Car Service Agreement which covers all cars not included in special agreements. In this agreement the Car Hire rate is 8 tenths of a cent per mile *plus 50 cents a day*, for cars over 15 tons capacity.

The following table giving the relative values of the various monies, weights and distances named in the responses will be found convenient for reference. While fractional values are omitted the figures are sufficiently accurate for comparison and adapted for ready calculation.

Monies.

—	American value.	English value.	Latin union value.	German value.
Anna (India)	2 cents.	1*d.*	10 centimes.	8 pfennigs.
Cent (America)	10 mills.	$^1/_2$*d.*	5 —	4 —
Centime (Latin Union)	2 —	$^1/_{10}$*d.*	...	$^8/_{10}$ pfennig.
Dollar (America)	100 cents.	4*s.*	5·00 francs.	4·00 marks.
Florin (Holland)	40 —	1*s.* 8*d.*	2·00 —	1·60 mark.
Franc (France)	20 —	10*d.*	100 centimes.	0·80 —
Heller (Austria-Hungary)	2 mills.	$^1/_{10}$*d.*	...	$^8/_{10}$ pfennig.
Kopeck (Russia)	$^1/_2$ cent.	$^1/_4$*d.*	2·5 centimes.	2 pfennigs.
Krone (Denmark and Norway)	25 cents.	1*s.*	1·25 franc.	1·00 mark.
Krone (Austria-Hungary)	20 —	10*d.*	1·00 —	0·80 —
Lira (Italy)	20 —	10*d.*	1·00 —	0·80 —
Mark (Germany)	25 —	1*s.*	1·25 —	100 pfennigs.
Ore (Sweden and Denmark)	$^1/_4$ cent.	$^1/_8$*d.*	0·0125 —	1 pfennig.
Pie (India)	$^1/_4$ —	$^1/_8$*d.*	0·0125 —	1 —
Penny (England)	2 cents.	...	10 centimes.	8 pfennigs.
Pfennig (Germany)	$^1/_4$ cent.	$^1/_8$*d.*	0·0125 franc.	...
Pound (England)	5 dollars.	20*s.*	25·00 francs.	20·00 marks.
Rouble (Russia)	50 cents.	2*s.*	2·50 —	2·00 —
Rupee (India)	32 —	1*s.* 4*d.*	1·60 —	1·28 mark.
Shilling (England)	25 —	12*d.*	1·25 —	1·00 —

Weights.

—	Pounds Avoirdupois.	Kilogram.
Kilogram.	2·2	...
Maund (India)	83·0	37·00
Poud (Russia)	36·0	16·38
Pound	...	0·454
Ton, Avoirdupois	2,240·0	1,016·0
Ton net (America)	2,000·0	907·2
Ton metric	2,204·0	1,000·0

Distances.

Kilometre	0·62 English miles.
Mile	1·61 kilometres.
Verst (Russia)	3,500 feet; 1,067 metres; 0·66 miles.

Nota. — The replies of the Administrations are published in the appendices of this report; they will be found in the *Bulletin of the Railway Congress* for January 1910, p. 28.

SECTIONAL DISCUSSION

Meeting held on 11 July 1910 (afternoon).

MR. DIETLER, PRESIDENT, IN THE CHAIR.

The President. (In French.) — I call upon Mr. Allen to address the meeting.

Mr. W. F. Allen, *reporter.* — The Permanent Commission was good enough to accord me the privilege of obtaining through the organization of the Congress, certain information respecting the interchange use of freight cars and the means taken to prevent their unnecessary detention by shippers and consignees, for the especial use of our American railways. The information requested was very kindly supplied by the administrations who were asked to do so, and it has been presented in the form of a " Note " to the present Congress.

From the nature of the replies received, it is evident that the problems which these two cognate subjects present, are of a similar character everywhere throughout the world, and that an entirely satisfactory solution of them has not as yet been developed anywhere.

Every management desires to make the best possible use of freight cars and to be able to command the services of its own cars whenever they are required. Each desires also to limit the haulage of empty cars as much as possible. The demands of trade appear sometimes to be antagonistic to these desired ends.

Interesting experiments are now being made in this branch of railway operation in various parts of the world, as for instance the " pooling " of all freight cars belonging to the administrations within the limits of the Empire of Germany.

While much valuable information was obtained for the " Note " which I have had the honour as a reporter to present, yet I am very conscious of the fact that the subject is by no means exhausted, if the best results of the investigation of the question are to be secured.

I would therefore move the adoption of the resolution presented, believing that the request therein contained will be favoured by operating railway officials in many of the countries represented in the Congress.

" The members of the third section who are especially interested in the operating of railways, respectfully request that the Permanent Commission will consider the utility of investigating the question of

freight-car interchange and demurrage, with the view of including it among the list of subjects to be discussed at the ninth session of the International Railway Congress."

Mr. Patterson, Pennsylvania Railroad. — On behalf of Pennsylvania Railway interests of U. S. A., I desire respectfully to add my word in favour of what my confrere Mr. Allen has said, more particularly as to interchange of equipment between Railways.

The road which I have the honour to represent is one of the largest owners of equipment in the world, and neither internally as between the different shades of opinion amongst our own officers, nor externally as regards our relations to other railroads have we reached any general universal principle on which to work.

When we turn to our friends in the old world for aid, the same failure to accentuate a definite general principle confronts us.

In some cases, they as well as ourselves accentuate the rights of the owners of equipment to receive back their cars on demand. On others, they accentuate the waste of mileage in any such course and its economic features from the standpoint of the shipper, and as intimated by Mr. Allen, it seems a world-wide problem well worthy of the consideration of this honourable body.

Mr. Hale, American Railway Association. — In seconding the resolution, I beg to say that the question is especially interesting in America, where the freight-car question is still an open one, and where the rates of payment for freight-cars have been changed even since Mr. Allen's note was presented. It has been said that the American situation is in fact a pool without regulation. This cannot continue indefinitely and the Americans are anxious in handling the question to profit by the experience of the railways in other countries, especially in Russia, India and Germany, where progress has been made in the regulation of freight-car pools. I feel also that this is a subject of special interest in these countries.

They have found that the periods when their cars have been on the whole most efficient were periods when the interchange has been the greatest, and that most present arrangements do not recognize this fact.

Mr. Lüttke, Prussian State Railway. (In German.) — Allow me to say a few words. It is within my knowledge that all the German railways belonging to the railway wagon union of the German States are perfectly satisfied with the existing state of affairs, as regards the question which we are considering at this moment. This union has regulations which approximately satisfy the object which Mr. Allen is aiming at in the case of the American railways. We, moreover, have fairly suitable conventions about the reciprocal use of wagons within the limits of all the countries concerned.

Nevertheless I am convinced that it would be very useful to continue the study of this subject and that, from this point of view, progress could be made by which the railways would benefit; not only the American railways, but also the other railways, perhaps also, last but not least, the German railways.

I hence strongly support Mr. Allen's motion.

Mr. Kareischa, *principal secretary*. (In French.) — The Russian railways have succeeded in coming to an agreement about the question of the interchange of rolling stock. The results obtained are favourable, but nevertheless I strongly support Mr. Allen's motion.

The President. (In French.) — I note that all the speakers support Mr. Allen's motion.

I accordingly declare it adopted.

DISCUSSION AT THE GENERAL MEETING

Meeting held on 16 July, 1910 (morning).

MR. P. WEISSENBACH, PRESIDENT, IN THE CHAIR.

GENERAL SECRETARY : MR. L. WEISSENBRUCH.

FIRST ASSISTANT GENERAL SECRETARY : MR. MÜRSET.

SECOND ASSISTANT GENERAL SECRETARY : DR. A. BONZON.

Mr. Kareischa, *principal secretary of the 3rd section*, read the

Report of the 3rd section.

(See *Journal de la huitième session*, No. 9, p. 15.)

" Mr. ALLEN brought forward his resolution and thanked the Permanent Commission for having allowed him to ask for information from the administrations, respecting the interchange use of rolling stock.

" From the replies kindly sent, it followed that this problem had not yet been solved satisfactorily. Every railway management desired to regularize the use of the rolling stock, and to make the best possible use of it. Interesting experiments were being made, more especially by combinations between railways, and the international study of this question would be of much interest.

" Mr. PATTERSON (*Pennsylvania Railroad*) seconded Mr. Allen's resolution; as his company was one of the largest owners of equipment, it would highly appreciate a good solution. The same difficulties appeared to turn up in other countries besides America. The owners of equipment accentuated their rights to receive it back as soon as possible. Shippers were as interested in the problem as the companies.

" Mr. HALE (*American Railway Association*) stated that the question was unsolved in America and that it would be desirable to regulate matters. In Germany, good results had been obtained. The best utilization had been when interchange had been greatest. It was desirable to know the experience of other countries, especially Germany, Russia and India.

" Mr. LÜTTKE (*Prussian State Railway*) stated that the German administrations were satisfied with the system adopted by

the union for the interchange of rolling stock. This question was important and its investigation should be continued.

" Mr. Kareischa (*Russian government*) mentioned that the Russian railways had arrived at an agreement on the subject of the interchange of rolling stock, and that it was desirable that uniform and general regulations should be adopted.

" The President noted that all the speakers had supported the proposal made by Mr. Allen; the 3rd section would submit this resolution to the Permanent Commission, so that it might be included in the agenda for the next session."

The President. — The following is the

RESOLUTION.

" The members of the eighth session, " who are especially interested in the " operating of railways, respectfully re- " quest that the Permanent Commission " will consider the utility of investigating " the question of freight-car interchange " and demurrage, with the view of includ- " ing it among the list of subjects to be " discussed at the ninth session of the " International Railway Congress."

— The general meeting confirmed this resolution.

II — MISCELLANEOUS MATTERS

1. — Letter from the Spanish ambassador at Berne.

At the general meeting of 14 July 1910, Mr. Weissenbach, President, read the following letter which had been sent to him by His Excellency Count de Chacon, the Spanish ambassador at Berne :

" Mr. President,

" I am directed to transmit to Your Excellency the greetings of His Majesty Don Alphonso XIII, with the request that you will have the kindness to inform the meeting of the interest which His Majesty feels in its work, which cannot fail to be productive for science and to form a new means for drawing the bonds of union between the different countries more closely together.

" I have the honour to be,

" Mr. President,

" Your obedient servant."

(*Signed*) Count de Chacon.

The meeting charged the President to request the Spanish ambassador to express to His Majesty King Alphonso XIII, the gratitude of the Congress Association for the interest His Majesty had condescended to take in its work, and to inform him that this Association especially appreciated the wish he had expressed of seeing the bonds uniting the different countries thus drawn more closely together.

* * *

2. — Telegram from the President of the United States.

Mr. W. H. Taft, the President of the United States, sent to Mr. Franklin Lane, the chief delegate of the United States government, the following telegram :

" I send greetings to whole International Railway Congress and sincerely hope that their conferences will result in general benefit and improvement of railway methods."

William H. Taft.

In reply to this telegram, Mr. Weissenbach, president of the session, sent the following letter to the United States ambassador at Berne :

" Sir,

" The International Railway Congress Association fully appreciates the expression of goodwill which the President of the United States, Mr. Taft, was kind enough to send by wire on the occasion of the official banquet of 14 July 1910.

" The Congress has charged me to request you to transmit to the President its gratitude for the interest he kindly showed in its work.

" I have the honour to be,

" Sir,

" Your obedient servant,"

(*Signed*) Weissenbach,

President of the eighth session of the International Railway Congress Association.

* * *

3. — Communication by Mr. P. de Tchérémissinoff.

Mr. P. de Tchérémissinoff, privy councillor, manager of the international services of the Russian railways and member of the Permanent Commission, reminded the Congress of the great interest with which it had listened, during the inaugural meeting of the eighth session, to the figures relating to the development of the Federal Railway in Switzerland.

This suggested to the Russian delegates the idea of presenting to the Congress a similar memoir relating to the railways in their country. Mr. de Tchérémissinoff laid on the table an abstract he had prepared of the great work of Mr. N. de Petroff, engineer general, head of the Russian delegates at the present Congress and president of a high commission of investigation of the railways in Russia. (*See addenda to various motions.*)

* * *

4. — Documents laid on the table.

a) *By the Mexican railways :*

Messrs. Rafael Garcia y Sanchez Facio and Estanislao Velasco, delegates of the Mexican government, presented the Congress with an account of the railways of the United States of Mexico, compiled for the eighth session by order of the President, General Diaz, and of the present secretary of communications, Mr. Leandro Fernandez. This interesting work contains a complete summary of railway affairs of this great Central American republic up to 31 December 1909.

b) *By the local committee organizing the eighth session :*

The local Swiss Committee, on the other hand, presented the delegates with the new federal law, of 23 June 1910, concerning the pay of the officials and the employees of the Swiss Federal Railway (referendum time expiring 4 October 1910).

— Copies of these documents have been placed in the library of the Permanent Commission.

ADDENDA TO VARIOUS MOTIONS

NOTE

ON THE

DEVELOPMENT OF THE RUSSIAN RAILWAYS,

By Pierre de TCHÉRÉMISSINOFF,

PRIVY COUNCILLOR,

MANAGER OF THE INTERNATIONAL SERVICES OF THE RUSSIAN RAILWAYS.

By 1904, the time when the Russo-Japanese war started, the amount expended by the Treasury on the construction of railways amounted to 11,500 millions of francs (£460 millions), and the national debt at that time amounted to 16,500 millions of francs (£660 millions).

A considerable part of the capital expended, namely nearly 3 milliards of francs (£120 millions), had however been supplied from the budgets of the financial years 1888 to 1904, thanks to the exceptionally favourable results of those years. On the other hand, the sums raised by loans had to cover the guaranteed payments, amounting to hundreds of millions, during the periods preceding the buying up of the different railway lines by the State.

At first the railways proved very expensive, although necessary for the gradual development of the State; but in 1898 they had yielded enough to pay 4·5 per cent on the capital expended by the treasury, plus a profit of about 60 millions of francs (£2·4 millions) to the State.

New main railroads were then built. Then came the war and internal troubles, and these resulted in a material increase in the working expenses.

Between 1888 and 1903, the total length of the Russian railway lines has approximately doubled, increasing by about 32,500 kilometres (20,200 miles); of these 24,000 kilometres (14,920 miles) are in Russia in Europe and 8,500 kilometres (5,280 miles) in Siberia.

The traffic grew, even in 1906, at a quicker rate than the railway system. The passenger traffic increased in the ratio of 1 to 2·13, the quick-freight traffic in that of 1 to 10, and the slow-freight traffic in that of 1 to 2·92.

The mean mileage, for the 93 millions of passengers, was 100 kilometres (62 miles), and for the goods, 450 kilometres (280 miles). The value of the goods carried in 1906 was nearly 8 milliards of francs (£320 millions), which as compared with 1888, represents an increase of 5 milliards of francs (£200 millions). The growth in the cereals traffic, representing a weight

of 40 million tons, corresponds to the increase in the area under cultivation. The vegetables, which could not be carried by river, had a total value of 800 million francs (£32 millions) (at 30 centimes per kilogram [1·31*d.* per lb.]). The sale of the goods carried, which produced about 3 milliards of francs (£120 millions), enabled the people to pay to the railways the sum of 375 millions of francs (£15 millions), the greater part of which was returned to them in the shape of salaries and of payments for materials consumed. The taxes could be raised materially. The mean tax paid per inhabitant had been 17·80 francs (14*s.* 3*d.*) in 1888; it had increased to 42·50 francs (£1.14*s.*) in 1906. Moreover, the ordinary receipts which amounted to 2·25 milliards of francs (£90 millions) in 1888 rose in 1906 to 5 milliards of francs (£200 millions).

The railways beyond the Ural Mountains have also materially benefited the State and the people, although the treasury had to spend an annual sum of 150 millions of francs (£6 millions) to pay the interest on the capital outlay and to cover the working deficits of some of the lines. This expenditure has above all helped towards the better defence of the frontier; the Southern line runs along more than 9,000 kilometres (5,600 miles) of this frontier.

The Siberian lines have, moreover, enabled a certain part of the population of Russia in Europe to emigrate in order to take possession of the vast fertile lands in Siberia and in the countries to the east of the Caspian Sea. This emigration was organized and assisted by the State. Every year five to seven hundred thousand men leave their homes in Russia in Europe in order to go east. The million hectares (2,471,150 acres) of land which hardly sufficed for them and which they leave to those who remain behind, represent a value of approximately a quarter milliard of francs (£10 millions); while they readily find in Asia the two million hectares (4,952,300 acres) which they require in order to give their energies full scope.

In this way, 400,000 families emigrated between 1901 and 1909, say 2 million people, and thus about 4 million hectares (9,884,600 acres) more land became available for the population of Russia in Europe.

The immigrants in Siberia receive, on the average, 7·3 hectares (18 acres) of arable land per family, yielding them a gross revenue of 125 francs per hectare (£2.0*s.* 5·6*d.* per acre). The total amount of these revenues in Siberia amounts to 375 millions of francs (£15 millions). The export of Siberian butter by itself produces a gross revenue of 125 million francs (£5 millions). The growth of cotton in the Transcaspian countries has reduced the imports of that article into Russia by about 250 millions of francs (£10 millions).

The legislature of the country has just granted large sums for duplicating the main Siberian line and the Transbaikal line, and for building a new line along the north bank of the Amur.

This great further expenditure will help to secure the safety of the frontier and will also help to develop the vast districts through which those lines will run.

CLOSING CEREMONY

On Saturday, 16 July 1910, at 10 a. m., the delegates assembled in the hall where general meetings were held. Mr. WEISSENBACH took the chair; Mr. DUBOIS, president of the Permanent Commission of the Congress, was on his right, and Mr. L. WEISSENBRUCH, general secretary, was on his left.

The meeting first dealt with the different sectional reports.

. . . . . .

THE GENERAL SECRETARY then read, in the name of the Permanent Commission, the following proposals which were passed :

A. — **Membership.**

" 1° That the appointment of the following members elected in the interval between the two sessions be approved :

" 1, BAÏDAK; 2, BIANCHI; 3, CECIL; 4, Lord CHURCHILL; 5, DETHIEU; 6, ELSNER; 7, FRANKE; 8, GLEICHMANN; 9, Fairfax HARRISON; 10, PHILIPPE; 11, H. Llewellyn SMITH; 12, STEINBISS; 13, TONDELIER.

" 2° That the following members be reelected :

" 1, RAMAECKERS; 2, BEAUGEY; 3, COLSON; 4, DE RUDDER; 5, DUTREUX; 6, GUERREIRO; 7, Frederic HARRISON; 8, OAKLEY; 9, ROUSSEAU; 10, SARRE; 11, STEVENS; 12, ULBRICHT; 13, WEISS; 14, DE WERKHOVSKOY; 15, VON ZLUHAN; 16, WEISSENBRUCH.

" 3° That in place of Messrs. JEITTELES and MASSA, deceased, and of Messrs. VON BILINSKI and NOBLEMAIRE, who are retiring, the following should be appointed members of the Permanent Commission : Dr. RÖLL, chief of section at the Imperial Royal Railway Ministry of Austria, vice-president of the session; Mr. GERSTNER, State councillor, representative of the directors of the Imperial Royal directorate of the lines of the Austrian State Railway Company, president of the 2nd section; Mr. CAJO, assistant general manager of the Italian State Railway; and Mr. MAURIS, director of the Paris-Lyons-Mediterranean Railway Company.

" 4° Messrs. ELLIOTT and KRUTTSCHNITT, whose appointments have expired and who do not wish their appointments to be renewed, are, by agreement with the American members present at the session, replaced by Mr. F. K. LANE, Commissioner of the Interstate Commerce Commission and vice-president of the eighth session, and Mr. W. F. ALLEN, general secretary and treasurer of the American Railway Association.

" 5° The Permanent Commission is charged to provide for the vacancy caused

through the recent death of Mr. Adadouroff, and of Messrs. Dietler, von Leber and de Marez-Oyens, who came under the operation of article 7 of the constitution.

" 6° As it is a regular practice to increase the number of places reserved in the Commission for the country which has received the Congress, the number of members for Switzerland is to be increased by two. The two new places are to be given to Mr. Winkler, technical manager of the Federal Railway Department, and to Mr. Flury, vice-president of the general management of the Federal Railway. " (*Applause.*)

" 7° Mr. Weissenbach, in his capacity of president of the eighth session, is appointed life-member of the Commission.

" In order to give the Scandinavian countries the place which formerly belonged to them, the vacancy to be filled is to be given to Mr. Ambt, general manager of the Danish State Railway."

The President laid the accounts on the table. Messrs. Carlier (*France*) and de Tchérémissinoff (*Russia*) were appointed auditors to check the accounts in accordance with article 19 of the constitution.

B. — Selection of meeting-place for next session.

The General Secretary. — " The Permanent Commission has considered suggestions respecting the choice of place for the next session.

" Germany has been proposed. No other proposals have been made. At the suggestion of Mr. Weissenbach, the president, the Permanent Commission proposes to you that the ninth session shall take place in Germany.

" The German delegates, on the proposal of Mr. Weissenbach, gave the Commission every assurance that the German government would be very happy to see the Association meet at Berlin and promised it an excellent reception." (*Applause.*)

The President. — " This acquiescence of Germany will certainly be received with gratitude on all sides. I hope that the Congress will accept with alacrity the proposal which has been made." (*Applause.*)

— " The proposition was accordingly passed."

Mr. Petri, vice-president. — " I thank you, gentlemen, in the name of the German delegates, for the flattering readiness with which you have accepted the invitation of Germany to hold the next session of the Congress at Berlin.

" The German empire, its capital Berlin and the administrations of the German railways have the greatest desire to give you a friendly reception and will make every effort that the Berlin session may prove worthy of the preceding ones.

" Returned to our homes, we, the German delegates, will tell everybody of the success of the eighth session of the Congress. We shall retain an ineffaceable remembrance of the laborious and agreeable days of this session as well as of the pleasant intercourse we have had with our colleagues from other countries.

" May our colleagues also retain as pleasing a recollection of us until the moment five years hence, when we shall have the great honour of calling you our guests and of bidding you welcome in Berlin, the German Imperial city.

" It is with this happy hope that we say to you: *au revoir in 1915 !* " (*Applause.*)

Mr. Weissenbach, president. — " Gentlemen, the eighth session of the International Railway Congress has closed its labours, and I have the great satisfaction of noting that the results of this meeting worthily add to the successes which have during twenty-five years marked the activity of the International Association.

" The first thought which a glance at these results inspires in us, is that of gratitude to the Permanent Commission at Brussels, which during five years has with untiring industry prepared the questions to be brought before the Congress. In the first place I must mention Mr. A. Dubois, who presides over it and has acquired the profound esteem and liking of all of us. Our gratitude is equally due to our general secretary, Mr. Weissenbruch, who has worked with remarkable activity and untiring zeal at the proper execution of the programme of the Congress. It is above all to his indefatigable industry that we owe it that we were able to carry out our work in so well-arranged and so regular a way.

" Our thanks are also due to the treasurer of the Congress, Mr. Holemans, for his indefatigable activity, to Mr. Verdeyen, the assistant-secretary, to the staff of the secretariat, and especially to the head of its office, Mr. Habran.

" We must also not forget the publication of the daily *Journal de la huitième session;* this work was carried out in a perfect manner under the direction of the Permanent Commission and of Mr. Mürset, the general secretary of the Federal Railway.

" The gratitude not only of the Congress, but of the whole railway world, is equally due to the eminent specialists whose reports, carefully elaborated, have enabled us to discuss thoroughly the most important questions relating to railways.

" We also thank the presidents and vice-presidents of the sections for the trouble they have taken and the work they have done, as well as their secretaries and all the staff of the different sections which has so actively seconded their efforts. It is due to their ability that the sectional discussions, although conducted in three languages, could be so thorough and so effective. I must specially mention the active share taken in the discussion of the most important questions by the English-speaking delegates who have come to us from all parts of the world.

" In conclusion, I still have to express the great satisfaction felt by the Congress in the interest shown in it by the Federal Council of the Swiss Federation, by charging Dr. Forrer, Federal Councillor, head of the Railway Department, with the formal opening of the Congress, and Mr. Comtesse, president of the Federation, with greeting us in its name. We especially thank Dr. Forrer, Federal Councillor, for having accepted the position of honorary president of the session.

" The work of the eighth session is finished, but that of our Association will continue without break, with the same indefatigable ardour, under the skilful direction of the Permanent Commission which is located in Brussels; and we are all quite convinced that the activity of the Congress will continue in the future to give excellent results for the development and the prosperity of the railways of the whole world." (*Applause.*)

Mr. Dubois, president of the Permanent Commission. — " Gentlemen, my first duty is to thank Mr. Weissenbach, who kindly consented to preside over the work of the eighth session and has done so with an ability, a zeal and an urbanity which you have been able to value. In my speech of 4 July, I recalled the eminent men whom we have had the good fortune to have as presidents at the first seven sessions; to that list of honour we add today the name of our president Mr. Weissenbach.

" In his speech, he gave words of praise to the Permanent Commission, to its president, its general secretary, and to Messrs. Holemans, Verdeyen and Habran. That praise is too flattering as far as I am concerned, but I accept it with great pleasure as regards my collaborators and especially Mr. Weissenbruch; better than anyone else have I long since been able to appreciate his qualities of intellect, of devotion to work and of moral energy.

" At the great banquet of 14 July, I was called upon to thank in your name the Federal government, which has treated us so generously and at the same time so cordially. You will recollect that entertainment, at which the President of the Federation magnified, in eloquent language, the functions of our Association, praised its past work and encouraged its future efforts. You will not forget that ingenious supplement to the banquet, that very cleverly-organized entertainment, which during two hours showed us all the scenes of Alpine life.

" We have also incurred a debt of gratitude towards the city of Berne. The municipal council invited us to a friendly meeting early on our opening day. We had hardly arrived and already we were at home, and that in a pleasant hospitable and comfortable home. We shall retain pleasing recollections of our stay in this charming city of Berne, admirably situated, surrounded with enchanting vistas, rich in glorious memories, which side by side with old picturesque buildings, carefully preserved, also offers us beautiful new buildings, many of which are veritable palaces.

" In my speech of the 4th instant I already mentioned the valuable assistance given by the provisional Swiss section to the Permanent Commission.

" Today, when the most complete success has crowned its efforts, I again wish to thank it, as represented by its president, Mr. Weissenbach and its secretaries, Messrs. Mürset and Bonzon. In truth, if any grumblers (and there are some in the Congress as elsewhere) want to raise some criticism against the superb programme elaborated by the Swiss section, the only one which they can find is that it gave no end of perplexity to those who had to make their choice among the excursions, all rivalling each other in interest, in usefulness and in pleasure.

" I also thank the chief committee of the Swiss section; the executive committee, presided over by Mr. Winkler, the secretarial committee, presided over by Mr. Mürset, having Messrs. Elskes and Étienne as chief collaborators; the local committees organized for Berne, Lausanne-Montreux, the Oberland, Lucerne and Zurich; and the Swiss secretary-reporters.

" I thank the public authorities, the administrations of the railways, tramway and navigation enterprises, the companies, and the private individuals who have

worked with goodwill, zeal and generosity in order to co-operate in the brilliant success which we can delight in today.

" Finally I thank the Swiss population which we have seen, so pleasant, so cordial, so ready to render services, and which we shall all leave with sorrow." (*Prolonged applause.*)

Mr. DE PÉTROFF, engineer general, member of the Imperial council of Russia, member of the Permanent Commission of the Congress and vice-president of the session. — " Gentlemen, allow me to address some words to you in the name both of my Russian compatriots and of myself. It is with the greatest interest that we have followed the development of the work of the Congress, which has attracted from all parts of the world a brilliant assembly of so many men of science, of talent and of great experience, able and competent to indicate here the quickest and safest means for solving questions of all kinds concerning railways.

" The work of the Congress was of quite special interest to the Russian representatives. Like everybody else in this world, we are convinced that there are imperishable ideals.

" Thanks to one of these ideas dating back to remote antiquity, the European people do not forget the wish of creating a convenient means of communication with the East Indies, with that cradle of the world where nature has accumulated inexhaustible riches and where we find again all the poetic and religious traditions of ancient and of modern nations.

" The first attempt of European people to make a way to India dates back to the celebrated expedition of the greatest general of antiquity, to Alexander of Macedonia, but the enterprise of this illustrious conqueror stopped when he had arrived on the banks of the Ganges.

" At the present time, thanks to the enormous progress of navigation and especially to the construction of the Suez canal, only one last step remains to be made.

" We hope and are convinced that the peaceful ideas and the sentiments of civilized people, and not universal warefare, will indicate to us the best means and those most suited to our times to realize the dream of antiquity.

" We shall develop there means by our activity in the construction of railways.

" Once we have grasped this and recognized its justice, we shall soon see, if we cast a glance at a map, that the shortest way from eastern Asia to western Europe is across the Russian territories in Asia and in Europe.

" Let us hope that the construction of these ways connecting eastern Asia and western Europe will not be long before it is realized. We are doing our best to construct and organize our railways in the way best suited to modern requirements, in accordance with the views of the Congress, so that our railways may form a suitable and convenient means of communication both for passengers and for the carriage of goods. It is for this reason that we have followed, with the greatest interest, the work of this Congress and that we wish the greatest success to future Congresses." (*Applause.*)

THE PRESIDENT then declared the eighth session closed.

PERMANENT COMMISSION

AND

EXECUTIVE COMMITTEE

elected at the General Meeting of the Congress on 16 July, 1910, and at the Meeting held by the Permanent Commission on the same date (arts. 5, 6 and 7 of the statutes).

Permanent Commission.

President :

A. **Dubois** (1), ingénieur, administrateur honoraire des chemins de fer de l'État belge, vice-président de la Société nationale belge des chemins de fer vicinaux, président de la Société des chemins de fer et minières Prince Henri.

Vice-presidents :

Alfred **Picard**, membre de l'Institut, ancien ministre de la marine, inspecteur général des ponts et chaussées, président de la section des travaux publics, de l'agriculture, du commerce et de l'industrie au conseil d'État de France;

Ch. **Ramaeckers** (2), secrétaire général honoraire du ministère des chemins de fer, postes et télégraphes de Belgique, administrateur de la Société nationale belge des chemins de fer vicinaux.

Ex-presidents of the sessions, members ex-officio :

Stuyvesant **Fish**, director, Yazoo and Mississippi Valley Railroad;

Nicolas **de Pétroff**, ingénieur général, membre du conseil de l'empire de Russie;

Alfred **Picard**, above mentioned;

Right Hon. Lord **Stalbridge**, chairman, London & North Western Railway;

P. **Weissenbach**, président de la direction générale des chemins de fer fédéraux suisses.

Members :

W. F. **Allen** (3), general secretary and treasurer, American Railway Association;

G. C. C. **Ambt** (1), directeur général des chemins de fer de l'État danois;

Sir George J. **Armytage** (1), Bart., chairman, Lancashire & Yorkshire Railway;

N. **Baïdak** (2), ingénieur, conseiller d'État actuel, directeur de la Compagnie du chemin de fer Moscou-Vindau-Rybinsk, président du comité permanent des conférences consultatives techniques des chemins de fer russes;

Frank **Barr** (1), third vice-president and general manager, Boston & Maine Railroad;

Beaugey (3), inspecteur général des mines, directeur des chemins de fer de l'État français;

Gustav **Behrens** (1), director, Midland Railway;

Richard **Bianchi** (2), ingénieur, directeur général des chemins de fer de l'État italien;

(1) Retires at the 9th session
(2) — — 11th

(1) Retires at the 9th session.
(2) — — 10th —
(3) — — 11th —

C. **de Burlet** (2), inspecteur général des ponts et chaussées, directeur général de la Société nationale belge des chemins de fer vicinaux;

Ausano **Cajo** (1), ingénieur, vice-directeur général des chemins de fer de l'État italien;

Amb. **Campiglio** (2), ingénieur, président de l'Union italienne des chemins de fer d'intérêt local et des tramways, administrateur du chemin de fer du Nord de Milan;

Evelyn **Cecil** (2), M. P., director, London & South Western Railway;

Lord **Churchill** (2), G. C. V. O., chairman, Great Western Railway;

C. **Colson** (3), membre de l'Institut, inspecteur général des ponts et chaussées, conseiller d'État, ancien directeur des chemins de fer au ministère des travaux publics de France;

De Rudder (3), administrateur-président chargé de la direction générale des chemins de fer de l'État belge;

A. **Dethieu** (2), administrateur des chemins de fer de l'État belge;

Tony **Dutreux** (3), ingénieur civil, président du conseil d'administration du chemin de fer Guillaume-Luxembourg;

Dr **Elsner** (2), Geheimer Ober- und Regierungsrat, vortragender Rat im Kaiserl. Deutschen Reichseisenbahnamt;

Theodore N. **Ely** (2), chief of motive power, Pennsylvania Railroad;

Flury (3), vice-président de la direction générale des chemins de fer fédéraux suisses;

Franke (2), Präsident der Königl. Preussischen Eisenbahndirektion, Altona;

Ernest **Gerard** (1), secrétaire général du ministère des chemins de fer, postes et télégraphes de Belgique;

Franz **Gerstner** (3), K. k. Regierungsrat, betraut mit der Stellvertretung des Direktors der K. k. Direktion für die Linien der österr. Staatseisenbahngesellschaft;

Professor Dr **Gleichmann** (1), Königl. Ober-Regierungsrat im Königl. Bayerischen Staatsministerium für Verkehrsangelegenheiten;

G. **Griolet** (1), vice-président du conseil d'administration de la Compagnie du chemin de fer du Nord français;

J. V. Mendes **Guerreiro** (3), ingénieur, inspecteur général des ponts et chaussées de Portugal;

Fairfax **Harrison** (2), president, Chicago, Indianapolis & Louisville Railway;

Sir Frederick **Harrison** (3), director, London & North Western Railway;

Chas. M. **Hays** (1), president, Grand Trunk Railway;

Émile **Heurteau** (2), ingénieur en chef des mines, délégué général du conseil d'administration de la Compagnie des chemins de fer de Paris à Orléans;

Franklin K. **Lane** (3), Interstate Commerce Commissioner;

L. F. **Loree** (1), president, Delaware & Hudson Railroad;

Jules **Ludvigh** (1), conseiller intime, membre de la Chambre des magnats, ancien secrétaire d'État et ancien président de la direction des chemins de fer de l'État hongrois, administrateur de la Compagnie internationale des wagons-lits et des grands express européens;

E. **Maristany** (1), directeur général de la Compagnie des chemins de fer de Madrid à Saragosse et à Alicante;

Mauris (1), directeur de la Compagnie des chemins de fer de Paris à Lyon et à la Méditerranée;

Sir Henry **Oakley** (3), director, Great Northern Railway;

Pérouse (1), inspecteur général des ponts et chaussées en retraite, directeur honoraire des chemins de fer au ministère des travaux publics de France, administrateur de la Compagnie des chemins de fer de Paris à Lyon et à la Méditerranée;

Georges **Philippe** (1), inspecteur général des lignes Nord-Belges;

Dr. Viktor **Röll** (1), K. k. Sektionschef im österr. Eisenbahnministerium;

César **Rota** (1), ingénieur, inspecteur supérieur, conseiller d'administration des chemins de fer de l'État italien;

(1) Retires at the 9th session.
(2) — — 10th —
(3) — — 11th —

(1) Retires at the 9th session.
(2) — — 10th —
(3) — — 11th —

Emmanuel **Rousseau** (3), conseiller d'État, directeur des chemins de fer au ministère des travaux publics de France;

R. **Sarre** (3), Geheimer Oberbaurat, Präsident der Königl. Preussischen Eisenbahndirektion, Kattowitz;

Albert **Sartiaux** (2), ingénieur en chef des ponts et chaussées, chef de l'exploitation de la Compagnie du chemin de fer du Nord français;

Sir H. Llewellyn **Smith** (2), C. B., permanent secretary, Board of Trade;

K. **Steinbiss** (1), Ober- und Geheimer Baurat, Mitglied des Kgl. Preussischen Eisenbahn-Zentralamtes;

G. W. **Stevens** (3), president, Chesapeake & Ohio Railway;

Pierre **de Tchérémissinoff** (2), conseiller privé, directeur des services internationaux des chemins de fer russes;

Tondelier (2), administrateur des chemins de fer de l'État belge;

Professor Dr R. **Ulbricht** (3), Geheimer Baurat, Präsident der königlichen Generaldirektion der Sächsischen Staatseisenbahnen;

Weiss (3), ingénieur en chef des ponts et chaussées, directeur de la Compagnie des chemins de fer de l'Est français;

de Werkhovskoy (3), ingénieur, conseiller privé, membre du conseil du ministre et du conseil pour les affaires des chemins de fer de Russie;

Robert **Winkler** (2), ingénieur, directeur technique du département fédéral suisse des chemins de fer;

Präsident **von Zluhan** (3), Regierungsdirektor, Vorstand der Verwaltungsabteilung der Generaldirektion der königl. Württembergischen Staatseisenbahnen;

N*** (Austria) (2);

N*** (Holland) (1);

N*** (Russia) (2);

N*** (Switzerland) (2);

General Secretary :

L. **Weissenbruch** (3), ingénieur en chef, directeur aux chemins de fer de l'Etat belge.

Secretary-Treasurer :

Éd. **Holemans**, inspecteur de direction honoraire des chemins de fer de l'État belge.

Assistant Secretary :

J. **Verdeyen**, ingénieur aux chemins de fer de l'État belge.

(1) Retires at the 9th session.
(2) — — 10th —
(3) — — 11th —

Executive Committee of the Permanent Commission.

The Executive Committee consists (art. 8 of the statutes) of the president, the ex-presidents of the sessions, five members (Messrs. Behrens, De Rudder, Gerard, Griolet and Ramaeckers (4)), the general secretary, the secretary-treasurer and the assistant secretary.

(1) Retires at the 9th session.
(2) — — 10th —
(3) — — 11th —
(4) Mr. Ramaeckers is the substitute of the president during his absence.

1885 * XXVth ANNIVERSARY * 1910

Permanent Commission

of the

International Railway Congress Association.

CHANGES

IN THE

CONSTITUTION OF THE PERMANENT COMMISSION

SINCE THE EIGHTH SESSION

(July, 1912)

Member ex-officio who is deceased :

Right Hon. Lord **Stalbridge**, director, London & North Western Railway.

Member who is deceased (vacancy unfilled) :

J. V. Mendes **Guerreiro**, ingénieur, inspecteur général des ponts et chaussées de Portugal.

New members :

Edson J. **Chamberlin**, president of the Grand Trunk and of the Grand Trunk Pacific, elected member in place of Mr. Hays, who is deceased.

Joseph de **Daragane**, ingénieur, conseiller d'État actuel, directeur du chemin de fer Riga-Orel.

Dinkelmann, président de la direction générale des Chemins de fer fédéraux suisses, elected member in place of Mr. Flury, who is deceased.

Ritter Bruno von **Enderes**, ingénieur, directeur général du chemin de fer Aussig-Teplitz.

Sir Guy **Granet**, general manager, Midland Railway, elected member in place of Sir Henry Oakley, who is deceased.

E. P. **Ripley**, president of the Atchison, Topeka & Santa Fe Railway, elected member in place of Mr. Frank Barr, who has resigned.

E. H. **Stieltjes**, ingénieur civil, membre du conseil de contrôle de l'État sur les chemins de fer néerlandais.

Vogel, Geheimer Regierungsrat, vortragender Rat im Reichseisenbahnamt, elected member in place of Mr. Elsner, who is deceased ([1]).

([1]) A few changes have occurred in the titles of members of the Commission. The names and titles given below are now correct :

A. **Dubois**, ingénieur, administrateur honoraire des chemins de fer de l'État belge, vice-président de la Société nationale belge des chemins de fer vicinaux, président de la Société des chemins de fer et minières Prince Henri, président de la Compagnie internationale des wagons-lits et des grands express européens;

ALFRED **Picard**, membre de l'Institut, ancien ministre de la marine, inspecteur général des ponts et chaussées, vice-président du conseil d'État de France ;

STUYVESANT **Fish**, director, Missouri, Kansas & Texas Railway ;

P. **Weissenbach**, ancien président de la direction générale des Chemins de fer fédéraux suisses ;

N. **de Baïdak**, ingénieur, conseiller d'État actuel, directeur de la Compagnie du chemin de fer Moscou-Vindau-Rybinsk, président du comité permanent des conférences consultatives techniques des chemins de fer russes, président de la Compagnie du chemin de fer Armavir-Touapse ;

Beaugey, inspecteur général des mines, ancien directeur des chemins de fer de l'État français ;

A. **Dethieu**, administrateur honoraire des chemins de fer de l'État belge ;

JULES **Ludvigh**, conseiller intime, membre de la Chambre des magnats, ancien secrétaire d'État et ancien président de la direction des chemins de fer de l'État hongrois, président de la Compagnie du chemin de fer Kaschau-Oderberg, administrateur de la Compagnie internationale des wagons-lits et des grands express européens ;

EMMANUEL **Rousseau**, conseiller d'État, membre du comité consultatif des chemins de fer, directeur honoraire des chemins de fer au ministère des travaux publics de France ;

R. **Sarre**, Geheimer Oberbaurat, Präsident des Königl. Eisenbahnzentralamtes ;

K. **Steinbiss**, Ober- und Geheimer Baurat, Präsident der Königl. Eisenbahndirektion, Kattowitz.

Appendix I^bis.

REPORT OF THE COMMISSIONERS,

appointed to audit the accounts for the period from 15 April 1901 to 15 April 1906.

In accordance with the mandate received by them from the Congress, at Washington, on 13 May 1905, the undersigned Commissioners have examined the management account presented by the Permanent Commission for the period from 15 April 1901, the date of the last audit, to 15 April 1906 They have found that it accords with the books, a comparison of which with the vouchers has been duly made, and they have pleasure in testifying to the perfect regularity of the figures.

The definitive account on 15 April 1906 thus shows a cash balance of 34,590·25 francs.

The undersigned append to the present report a comparison made between the expenses of the period under examination and those of the preceding quinquennium, showing, for the present period, a difference of minus 20,430·73 francs (see annex I).

The present report should, in conformity with article 19 of the statutory rules, be presented to the Congress due to assemble at Berne, together with the preceding report, which was communicated to the Permanent Commission on 6 July 1901 (see annex II), with a view to their being appended to the official report of the Congress.

Brussels, 6 October 1906.

The Commissioners :

L. Carlier, P. de Tchérémissinoff.

Annex I to the report of the commissioners, of 6 October, 1906.

COMPARISON OF EXPENSES,

for the periods 1901-1902 to 1905-1906 (Washington) and 1895-1896 to 1900-1901 (Paris).

NATURE OF EXPENSES.	Seventh session (Washington).		Sixth session (Paris).		DIFFERENCES for the seventh session :				The provisional account, including the estimates for 1905-1906, shows :	
					Plus.		Minus.			
	Fr.	C.	Fr.	C.	Fr.	C.	Fr.	C.	Fr.	C.
Printing	309,194	81	302,975	83	6,218	98	...	...	294,436	34
Other expenses	81,642	24	75,289	15	6,353	09	...	...	77,957	81
TOGETHER	390,837	05	378,264	98	12,572	07	...	...	372,394	15
Sessions	273,815	06	249,558	85	24,256	21	...	...	265,091	44
TOTALS	664,652	11	(1)627,823	83	36,828	28	...	...	637,485	59
			57,259	01	...	...	57,259	01	...	...
					— 20,430·73					
Temporary expenses	2,281	25	...	...	...	...	...	...	2,281	25
Deferred printing expenses belonging to the preceding session	57,259	01	...	...	...	...	...	...	57,259	01
Repayment to Savings Bank	50,000	»	...	...	...	...	...	...	50,000	»
GENERAL TOTALS.	774,192	37	685,082	84	...	...	...	...	747,025	85

(1) The sum of 627,823·83 francs has to be augmented by 57,259·01 francs belonging to the financial year 1900-1901 (sixth session), but paid in 1901-1902 (seventh session).

Annex II to the report of the commissioners, of 6 October, 1906.

REPORT OF THE COMMISSIONERS

appointed to audit the accounts from 15 April, 1896 to 15 April, 1901 (1).

In fulfilment of the mission entrusted to them by the Congress at Paris, on 29 September, 1900, the undersigned Commissioners have examined the *provisional* management account presented by the Permanent Commission for the period from 15 April, 1896 to 1 September, 1900 and laid upon the table at the sixth session.

They have, in addition, verified the *definitive* account embracing the complete period from 15 April, 1896 to 15 April, 1901. They have found it in accordance with the books, supported by the requisite vouchers.

The operations of this period of five financial years may be summed up as follows :

Cash in hand on 15 April, 1896 . . fr.	10,383·71
Receipts and loan	657,008·54
Together . . . . . fr.	667,392·25
Expenses liquidated.	630,106·68
Surplus of receipts . . . fr.	37,286·17

The definitive account thus shows a cash balance, on 15 April, 1901, of 37,286·17 francs.

Brussels, 6 July, 1901.

The Commissioners :
L. DE PERL, L. CARLIER.

(1) See the *Summary of Proceedings* of the sixth Session (p. 291) : " The meeting appointed Messrs. Carlier (France) and de Perl (Russia) auditors."

Appendix II.

PROGRAMME OF EVENTS

Saturday, July 2nd.

From 2 to 6 p. m. — Registration of delegates.

Sunday, July 3rd.

From 9 a. m. to 2 p. m. — Registration of delegates.

Monday, July 4th.

From 9 a. m. to 2 p. m. — Registration of delegates. Constitution of the lists of sections.

At 5 p. m. — Reception of the members of the eighth session of the Congress by Dr. Forrer, head of the department of posts and railways. **Formal opening.**

At 8.30 p. m. — Evening party at the Casino rooms, given by the municipal council of the city of Berne.

Tuesday, July 5th.

At 9 a. m. — Meetings of the sections.

At 2 p. m. — Meetings of the sections.

At 4 p. m. — Visit to the Hasler telegraph works.

Wednesday, July 6th.

At 9 a. m. — Meetings of the sections.

At 2 p. m. — Meetings of the sections.

At 4 p. m. — Visit to the Tobler chocolate factory.

Thursday, July 7th.

Excursions for delegates to the Bernese Oberland and to the Lake of the Four Cantons.

Friday, July 8th.

At 9 a. m. — Meetings of the sections.

At 2 p. m. — Meetings of the sections.

At 4 p. m. — Visit to the Roll foundry.

Saturday, July 9th.

At 9 a. m. — Meetings of the sections.

At 2 p. m. — Meetings of the sections.

At 4 p. m. — Visit to the water-power and electric plant of the city of Berne.

Monday, July 11th.

At 9 a. m. — Meetings of the sections.

At 2 p. m. — Meetings of the sections.

At 4 p. m. — Visit to the gas-works and to the Ryff weaving-mill (1st party).

Tuesday, July 12th.

Excursions for delegates to Lausanne-Montreux and to Zurich.

Wednesday, July 13th.

At 9 a. m. — Meetings of the sections.

At 4 p. m. — Visit to the Felsenau spinning-mill and to the Ryff weaving mill (2nd party).

Thursday, July 14th.

At 9 a. m. — Meetings of the sections.

At 2 p. m. — General meeting.

At 4 p. m. — Visit to the central telephone office.

At 7.30 p. m. — Banquet tendered by the Federal Council, followed by an entertainment.

Friday, July 15th.

At 9.30 a. m. — General meeting.

Saturday, July 16th.

At 10 a. m. — General meeting and formal closing of the session.

VISITS TO WORKS, EXCURSIONS AND RECEPTIONS

Reception of the members of the Congress by the city of Berne, Monday 4 July 1910, at 8.30 p. m., at the Casino.

Berne local committee.

President :

Mr. R. Winkler, technical manager of the Federal Railway Department.

Members :

Mr. Adrian, president of the *Berner Liedertafel;*
Mr. Auer, manager of the Lake Thun Railway;
Mr. Bahler, president of the provisioning committee of the federal shooting festival;
Mr. Behrmann, manager of the information bureau;
Mr. Flückiger, president of the development society;
Mr. Bracher, president of buildings committee of the federal shooting festival;
Mr. Dinichert, assistant secretary at the federal political department;
Mr. von Fischer, president of the municipal council;
Mr. Henzi, president of the *Kreisgesangverein;*
Mr. Keller, architect of the federal buildings management;
Mr. Könitzer, member of the executive council of the canton of Berne;
Mr. Kreis, colonel;
Mr. Probst, lieutenant-colonel;
Mr. Sand, member of the general administration of the Federal Railway;
Mr. Schieb, gentleman;
Mr. Steiger, mayor of the city;
Mr. Trüssel, president of the town orchestra;
Mr. Vuilleumier, head of the advertizement department of the Federal Railway;
Mr. Widmer, professor of gymnastics;
Mr. Wälchli, president of the general gymnastic society.

Chief secretary :

Mr. Gribi, secretary at the Federal Railway Department.

Assistant secretary :

Mr. Leumann, official at the Federal Railway Department.

Hardly arrived at the federal city, and but a few hours after leaving the great hall of the Casino, where the opening ceremony had taken place, the members of the Congress, accompanied by their ladies, once more turned their steps towards the beautiful building, of which Berne may justly be proud, in response to the invitation of the municipal council.

At the entrance, pretty young girls, in the charming and picturesque Berne costume, offered flowers to the arriving guests. At 8.30 the great hall, as well as the citizen's hall, brilliantly illuminated and decorated with perfect taste, already sheltered the majority of the Congress members; the federal, cantonal, municipal and local authorities were extensively represented, as well as the Swiss and the foreign press. Small tables were laid everywhere, except in the great hall, where there was only one row of them next to the walls, so as to leave the whole central part available for the free circulation of the guests. The bad weather unfortunately prevented them from walking about on the great terrace and enjoying the incomparable view generally to be obtained there. The town orchestra, hidden on the platform by a screen of green, performed the finest pieces of its repertoire; sumptuous buffets were arranged and an excellent cold supper was served, together with very good wine.

By a delicate attention, the municipal council desired to prevent this gathering having anything of a formal or official character, so that the members of the Congress should from the first day be able to feel the charms of the hospitality which the old city of Berne offered to them; no speeches were made, and Mr. de Steiger, the amiable mayor of the town, even seemed desirous of avoiding the thanks and grateful acknowledgements of his guests.

It was a truly picturesque gathering, where many of the languages of the world were represented and where the delegates who attended former sessions at Washington, Paris, London, etc., very soon renewed the excellent relations they had formed in one or the other of those capitals; a very cordial reception at which the newcomers, seeing the pleasantness of these meetings and encouraged by the simplicity of the Swiss hospitality which was offered to them so good-heartedly, very soon felt as much at their ease as the old ones. But the hour advanced and the sectional meetings were going to begin next morning, with their hard and arduous work, which would leave but little time for pleasure. In the opinion of everybody, it was too soon that parting became necessary. All the members of this charming gathering will certainly retain the best recollection of Bernese cordiality and of the first evening passed by the members of the Congress in Berne.

Excursion to the Bernese Oberland, Thursday 7 July 1910.

Local Oberland Committee.

President :

Mr. Burkhart-Gruner, president of the administration Council of the Bernese Oberland Railway.

Members :

Mr. Borter, innkeeper, at Interlaken;
Mr. Brawand, innkeeper, at Interlaken;
Mr. Liebi, manager of the Steam Navigation Company on the lakes of Thun and Brienz;
Mr. Liechti, traffic manager of the Jungfrau Railway;
Mr. Matti, president of the Development Society at Interlaken;
Mr. Dr. Michel, State councillor, president of the Casino Society at Interlaken;
Mr. Müller, manager of the Victoria Society at Interlaken;
Mr. Räuber, president of the administrative Council of the popular bank at Interlaken;

Mr. Seewer, president of the Interlaken municipality;
Mr. Seiler, deputy of the great Council, at Bönigen;
Mr. Seiler, innkeeper, at Interlaken;
Mr. von Steiger, traffic manager of the Wengernalp Railway;
Mr. Wirth, traffic manager of the Bernese Oberland Railway;
Mr. Wirth, innkeeper, at Interlaken;
Mr. Wyder, innkeeper, mayor of the Interlaken commune.

Secretary :

Mr. Hartmann, manager of the information bureau at Interlaken.

Head of the Excursion :

Mr. O. Sand, member of the general administration of the Federal Railway.

Assistants :

Starting from Berne : Mr. Dinichert, secretary at the Federal political Department;
Starting from Thun Hofstetten (ship) : Mr. Liebi, manager of the Steam Navigation on the lakes of Thun and Brienz;
Starting from Scherzligen (railway) : Mr. Kunz, president of the administrative Council of the Lake Thun Railway;
At Interlaken : Dr. Michel, state councillor;
For the 1st group, Beatenberg : Mr. Hartmann, manager of the information bureau at Interlaken;
For the 2nd group, Schynige Platte : Mr. Burkhart-Gruner, president of the administrative Council of the Bernese Oberland Railway;
For the 3rd group, Mürren : Mr. Wirth, traffic manager of the Bernese Oberland Railway;
For the 4th group, Wengernalp-Scheidegg : Mr. von Steiger, traffic manager of the Wengernalp Railway and Dr. Michel, State councillor;
For the 5th group, Lötschberg Railway : Mr. Hirter, president of the administrative Council of the Lötschberg Railway.

It rained! It rained pitilessly and old visitors asked themselves rather doubtfully what an excursion into the mountains would be like in such weather.

But the majority of those members of the Congress who had selected the Oberland as the place of their excursion did not allow themselves to be intimidated by the bad weather and started from Berne cheerfully, relying on their good star and on the cordiality of their Swiss friends to make up for the absence of sun should the latter remain hidden. The arrival at Thun and at Scherzligen took place under very pleasant conditions which put everybody in a good humour. Charming girls, clad in the picturesque Bernese costume, awaited the members at the stations, placed flowers in their buttonholes and presented the ladies with pretty bunches of Alpine roses.

At Scherzligen the school cadet corps was drawn up on the quay, with rifle or crossbow on the shoulder, and the members passed from the train to the ship to the sounds of lively music while guns fired salutes.

All of this had so much local colour, a colour so simple, so wholesome and so cordial, that the members broke out into applause, and it was in the middle of cheers which were returned from the shore that the ship took the excursionists to the end of the pretty lake of Thun, whose beauties were unfortunately hidden by the mist.

At Beatenbucht and at Interlaken the excursionists were divided into groups and then proceeded to the places named in their invitations.

1st group : Beatenberg.

The delegates and their ladies forming the 1st group of the Bernese Oberland excursion, left the steamship *Blümlisalp* and the members of the other groups at Beatenbucht.

They were received on the pier by Mr. Hartmann, manager of the Society for developing the Oberland and secretary of the local reception committee, who placed himself corteously at their disposition and gave them all useful information.

At 9.30 a. m. the members took the cable railway which goes up the Beatenberg, to a height of 1,150 metres (3,773 feet). This line, which is 1,695 metres (1 mile 94 yards) long, was opened to traffic in 1889; the cost of construction amounted to 700,000 francs (£28,000), which corresponds to 413,000 francs per kilometre (£26,585 per mile). From 1889 to 1909, it carried 873,645 passengers, or an average of 43,000 per year.

The difference in height between Beatenbucht station, on the shores of the lake of Thun, and Beatenberg station is 556 metres (1,824 feet); the mean gradient is 34·8 per cent, and the steepest gradient is 40 per cent. The track consists of two ordinary rails and of a rack rail. Each carriage can hold forty-eight passengers, and it is equipped with three brakes, any of which can stop the carriage almost instantly.

In order to start the carriages, the upper carriage is given the necessary overweight, loading it with water if required, to enable it to pull up the carriage which is below.

The railway has two cables which are 32 millimetres (1 1/4 inches) in diameter and have an ultimate tensile strength of 80,000 kilograms (176,370 lb.); these cables were tested at the Zurich federal laboratory and the tests made showed that the factor of safety is ten.

The ascent took sixteen minutes and offered the passengers a series of marvellous views.

When the train arrived at Beatenberg station, a number of carriages awaited the excursionists in order to take them to *Hôtel Victoria*. The weather which had been bad in the morning, improved a little; members were therefore able to take a very pleasant hour's walk on the mountain and enjoy the splendid view over the lake of Thun and the snowy summits of the Bernese Alps.

An excellent lunch served in an irreprochable manner was supplied to the members in one of rooms of the *Hôtel Victoria*, decorated with the flags of the different nations represented at the Congress and with Alpine flowers. The greatest cordiality was prevalent; one of the delegates expressed in a few words the gratitude of everybody and requested Mr. Hartmann to thank the local Oberland committee for the care and the attention shown them.

At 4 p. m. the delegates descended by the cable railway, once more contemplating the magnificent view of the Niesen which is obtained on coming out of the branch tunnel, and soon afterwards they embarked on the *Stadt Bern* which took them to Interlaken, where they rejoined the other groups of excursionists.

2nd group : Schynige Platte.

Wilderswil is the terminus of the Schynige Platte Railway. It was from that station that the members of the 2nd group started the ascent with the same enthusiasm as if it were magnificent weather. And yet the rain continued to fall, but without succeeding in affecting the good humour of the excursionists. They admired the scenery with the eye of faith, for heavy mists obscured the

view and only the valley remained visible. But the latter is so beautiful, it gives such magnificent glimpses of the lakes of Brienz and of Thun that limited though the view was, it was still very beautiful.

At the intermediate station of Breitlauen, there was a stop of several minutes, where the excursionists successfully struggled against the outward damp by "internal stoking" (as one of their kind guides called it) with a glass of Madeira. The top was reached in the middle of a fog which was continually becoming thicker; the rain had ceased but was replaced by snow which fell in great flakes and covered the ground with a white carpet. The thermometer marked —1° C. (30·2° Fahr.), and this made one appreciate to the full the comforts of a warm room where a table covered with flowers awaited the excursionists, and where there was a cordial reception from which all formality was banned.

One gaily sat oneself at the table, with the hidden hope that the sun would succeed in conquering the fog and the snow. This hope was not realized, but everybody was in such high spirits and the hosts were so pleasant that one finished by forgetting the weather and only thought of the cordiality of the assembly.

At dessert, Mr HUBERTI (*Belgium*) rose and addressed the following remarks, which were received with much applause by the company :

"Ladies and gentlemen, do not be afraid; I am not going to make a speech. However short such a one might be, it would be out of place at this friendly gathering where all formality has been carefully eliminated. But I particularly wish to thank in my own name, and in the name of my Belgian friends, and I think I may add in the name of all of you as well, the organizers of this delightful reunion. They have solved a difficult problem. They have shown themselves superior to the sun, and an excursion which for a single tourist would have been a lamentable failure, has been converted by them into a day of pleasure which will always be a most pleasant recollection to us. I therefore raise my glass to the health of the organizers of this excursion, and in particular to Mr. Burkhardt whose kindness and extreme amiability you have all been able to appreciate during our journey."

Mr. BURKHARDT remarking that the programme had provided for neither toasts nor speeches, regretted that he was unable to reply in French to Mr. Huberti, and thanked the latter for his kind words. The organizers, he stated, did all they could to ensure the success of the excursion, but they could not compel the sun to join them, in order to enable their visitors to admire the beautiful mountains about them. Mr. Huberti's words would result in adding to the cordiality of the meeting and would perhaps recall to its duties the sun, which at that moment seemed as if it might break through the curtain of snow. Mr. Burkhardt expressed the hope that before the time for departure arrived, the skies might clear, if only for a few minutes, so as to make visible the magnificent panorama of the Bernese Alps. But he expressed the hope, should this not prove to be the case, that before the delegates left Berne the sun would favour them; and he invited them very cordialy to profit by it and to come once again to the Schynige Platte.

The afternoon was passed in very animated conversation; the female employees of the hotel, grouped in a corner of the room, gave popular songs which were much enjoyed by the guests, and when the hour for departure arrived, everybody was surprised how quickly the time had flown.

3rd group : Mürren.

The members forming the 3rd group of the Oberland excursion, thirty-five in number, parted from the 2nd group at Wilderswil and directed themselves towards Mürren, and took the Grütschalp cable railway. They were truly carried up into the clouds! Up above, clouds, down below, same view! They observed attentively pastures which were still visible, the mossy fir-trees which were along the iron road, the splendid Alpine flora, among which one saw bell-flowers of all sizes and shades, thistles of all kinds, Alpine roses, blue gentians, etc. During the ascent, a sharp eye could see that the Staubbach waterfall is very beautiful, but the mists which surrounded it did not allow everyone to distinguish it. Lighted up by a bright sun and surrounded with its rainbow, it would be a very different sight!

The members of the local committee charged with accompanying the guests took their place at the back of the train and by their merry jests brought back a ray of gaiety and proved to their guests that in Switzerland one knows how to be cheerful under difficulties. At Grütschalp, all changed from the cable line to the electric line. Suddenly the train stopped, then it started again, with difficulty it seemed. One heard the cracking of a whip and the cheerful sound of bells; one looked out and wondered whether double-heading had become necessary! This is what had happened : the driver of the train tried to drive away several cows who were taking a walk on a track; but as they were unable to find any way out they thought it advisable to trot ahead in front of the train! At the *Kurhaus* a reception, warm in two senses, attended the delegates who could not refrain from an appreciative exclamation when they entered the dining room, beautifully decorated with rhododendrons. An ample lunch was served to the sounds of an excellent orchestra.

An alteration had to be made in the official programme, as the walk which it included could not be taken. The local committee knew how to make up for it, and as no yodeller was there to entertain the guests, it yodelled itself in an excellent manner, and in addition sung sundry Helvetic songs!

The room was soon full of cheerfulness. The time passed so quickly that everybody was surprised when the clock struck four and reminded one that it was time to start. During the descent there was more wind, and rain, and snow; the torrents and the waterfalls alone were beautiful.

4th group : Wengernalp-Scheidegg.

In spite of the rain which had been falling continuously since an early hour, a body of more than two hundred members took the train of the Wengernalp line at Lauterbrunnen, in order to go to the freshly-fallen snow and to the eternal snow. Some chilly people went into carriages equipped for a winter service, while the sons of Albion and their cousins from over the seas boarded the carriages used for the summer service. Each one received, with much pleasure, a charming collection of picture postcards graciously presented by the Wengernalp Railway Company.

The hour for departure had arrived; the train went ahead and proceeded silently on its journey, for the first time, for that day was just the day on which electric traction was inaugurated. At last good-bye to Lauterbrunnen and to the Staubbach fall, which is surrounded by a large number of small falls fed by the continuous rain of the last few days, and

then the view was hidden by entering a long tunnel, lit up electrically. After leaving the tunnel, the train continued its ascent through the fog and passed along the Wengen plateau, saluted by its inhabitants. It then reached Wengernalp, where the animal which is symbolic of Berne bade the arrivals welcome.

The young girls of the district, wearing their pretty Oberland dresses, the Simmenthal head-dress ornamented with a crown of rhododendrons, presented to the train the flags of the States represented at the Congress, while the Interlaken male choir intonated a song in order to salute the guests and the Fatherland. During the lunch, the Interlaken choir gave happy moments to everybody, enabling one in this way to appreciate how song is cultivated on the free soil of Switzerland, even in the most retired valleys of the Alps.

Soon after the arrival at the Little Scheidegg, the weather looked as if it would clear; but at 2 p. m., at the moment of starting back to Interlaken, snow began to fall heavily and continued till it gave place to rain.

5th group : Lötschberg.

In spite of the unsatisfactory state of the weather, one hundred and six members, among whom were several ladies, met at the placed fixed for the start of the 5th group, which was under the direction of Mr. Kunz, the president of the Lake Thun Railway.

When passing Spiez, the excursionists admired the electric cars wich will soon run between that station and Frutigen.

On the arrival of the train, the guests were accommodated in a dozen open breaks comfortably equipped with good rugs, and several closed carriages received the ladies and Mr. Comtesse, president of the Confederation, who honoured the excursion with his presence.

The skies remained covered, but did not prevent enjoying the beauties of the road from Frutigen to Kandersteg, which presents such charming and varied views.

At Kandersteg lunch was given at the *Hôtel de l'Ours*, and the guests seated themselves at table with an appetite sharpened not only by exercise, but also by the fresh and light air. During lunch time a ray of the sun gave for a moment the hope of better weather.

Mr. Hirter, president of the Lötschberg Company, rose, as he said, not to make a speech, but only to give particulars of the visit to the installations.

When the time came, the whole assembly started on the way under the leadership of the amiable general manager of the works, Mr. Zürcher, and of his engineers who were very polyglot in their attainments and who gave every information about the works with indefatigable readiness.

After walking through the workshops, seeing a drill at work, and noticing the very interesting operation of pointing the drills, the delegates mounted the small cars which are used by the workmen in order to take them into the tunnel; and the compressed-air locomotive took them quickly to kilometre 3. This part was quite completed and one saw the air conduit, formed by a partition and one of the sides of the tunnel, through which the fresh air was led up to this point. A blower then took this air and sent it, in iron piping having a diameter of 50 centimetres (1 ft. 7 $^{11}/_{16}$ in.), to the working face. The blower and its motor were on a carriage, and could be moved on as the work advances. The electric line here also terminated in a transformer which was on a carriage, which also could be moved on.

As the tunnel is of double-track section

and is very well ventilated, the stay in it left no unpleasant feelings.

Outside the delegates again found the breaks and the carriages, and the return journey was begun.

A half-way stop was made for a short visit to the charming " Blue Lake", so prettily surrounded with fir trees and with rocks. Its water is remarkably transparent, and those who had time to go on it in small boats were enchanted.

The Lötschberg Company offered refreshments, Swiss champagne, in the pretty refreshment chalet, and everybody carried away a souvenir, in the shape of a chromo, showing a pretty landscape; these were courteously presented by the tenant of the chalet, who is well known under the name of the " Blue Lake Director ".

The guests took the train at Frutigen in order to return to Interlaken.

* * *

The different groups of the Oberland excursion met again at Interlaken in order to be present at the banquet given at the *Hôtel Métropole*, the *Hôtel Victoria* and the *Hôtel des Alpes*.

The weather had not had the least influence on the cheerfulness of the members and everyone was pleased, in spite of everything, with his day.

At dessert Mr. Lutz, the mayor of the town, made the following speech :

" Ladies and gentlemen, in the town where your Congress is at present holding its session, in the federal city of Berne, a monument of bronze is erected on an eminence; it represents a young man, his eyes turned towards the glittering summits of the Alps which hide the horizon. This is the statue of the man whom Berne honours most, the statue of the great Albert von Haller.

" During centuries our Alps only inspired men with horror, with fear and with terror; all those who were not forced to live in their neighbourhood fled them.

" It was given to Haller, thanks to his investigating spirit, to be one of the first to place his traveller's staff on the mountains, to walk through their valleys and their abysses and to discover their beauties, thus rising superior to the prejudices of the men of his time. Haller thus became the herald of our Alps, the one who revealed in the clearest way to his contemporaries and to posterity, the charm, the majesty, the beauty and the grandeur which our unappreciated mountains concealed.

" And yet, after that, nearly a hundred years passed before the foot of man was first placed on the top of the Jungfrau; mankind only followed Haller's appeal with fear and trembling; it was reserved for present times to understand the mountains, and to make their magic attraction felt everywhere. Thanks to your constructions, gentlemen of the winged wheel, and to those in whose footsteps you followed, our Alps which were ignored so long have become the meeting-place of the whole world which sends us year by year caravans of those who feel the need of coming and of gaining strength on our mountains, in our valleys.

" And as this traffic became developed, so did the star of Interlaken rise. After a very modest start, our town has gradually become the centre for all the tourists to the Oberland. And the existing importance which Interlaken has acquired is closely dependent on your work and on that of your predecessors, thanks to the ribbon of steel which connects us with other nations, and to the hardy exploits which have enabled you to conquer the mountains.

" Fully cognizant of all this, it is with quite special satisfaction that we today wish you, ladies and gentlemen, a cordial welcome in our district.

" In the name of the population of Interlaken and of its authorities, whom I here represent, I raise my glass to your health."

In answer to this friendly welcome, Mr. DE PRÉAUDEAU, vice-president of the general council of bridges and roads of France, and delegate of the French government, returned thanks in the following terms :

" Ladies and gentlemen, it was for a member of the Permanent Commission to express to the municipality of Interlaken the gratitude of the Congress delegates for this brilliant reception; it is owing to his absence, caused by an unforeseen obstacle, that I have to speak here.

" The sumptuousness of this entertainment does not make us forget gratitude due to the local organizing committee for having enabled us, by suitably-combined excursions, to admire, in spite of the unfavourable weather, a certain number of the picturesque spots of which Switzerland is justly proud.

" In this district, so celebrated as a centre for Alpine excursions, we do not know what to admire the more : the beauties of nature or the talent of the engineers who by their bold work have made it possible to bring this marvellous scenery within the reach of visitors who are tired or hurried.

" The latter fully appreciate the great aptitude of the Swiss nation in discharging the rites of hospitality, so luxuriously exercised today on our behalf.

" We will not forget to include in our thanks the Interlaken Casino Society, which has invited us to a concert followed by a firework display, so as to finish, in the midst of yet another entertainment, this day which has already been so well occupied.

" I lift my glass in honour of our hosts and drink to the prosperity of the city of Interlaken." (*Applause.*)

While these speeches were made at the *Hôtel Métropole*, Mr. MICHEL, State councillor, president of the Interlaken Casino Society, made the following speech at the *Hôtel Victoria* :

" Ladies and gentlemen, it is in the names of the city of Interlaken and of the Bernese Oberland that I have the honour of wishing you a hearty welcome, a wish bearing the imprint of much greater cordiality than could have been the case thirty or forty years ago. It suffices, in fact, to compare the very different attitude of other nations towards you, now and in the past, in order to form even an approximate notion of how great and strong must have been your spirit of initiative, your capacity for work, your creative power which never retreated in front of any danger, of any responsibility !

" You do not even retreat before the gods : you do not even retreat before Jupiter Pluvius, who in spite of our applications to him, has refused to give his rule to the sun or to the queen of our Alps, the Jungfrau. All the same you have carried out your day's programme.

" Time has been necessary in order that all might understand your work, and thirty or forty years ago you would have run a considerable risk in many inhabited places of being received with stones thrown at your heads, whereas today the populations everywhere express their respect and their gratitude to you, for now they know that you bring with you prosperity and peace and goodwill among nations.

" But it has not always been so, and you know this better than I do. Thus at the distant period when the progress of which you are the representatives made unavoidable changes necessary in the methods of communication, cries of indignation were raised. One heard, more than once, and nearly everywhere, strong protests; and history records, in France for instance, the violent sarcasms of Thiers, in the time of Louis-Philippe, denouncing the railway as a smoky toy which would not last for six months; and the celebrated scientific deductions of a François Arago that a locomotive would not be able to move!

" Well! In all countries, in Germany as in France, in Italy as in Switzerland, very great men made mistakes.

" Were all these recriminations foolish? This is not the time for considering this question

and I will not even discuss the objection so often raised of the destruction of fine views.

" There is a French proverb which says, you can't make omelets without breaking eggs, and it is true that those iron roads which at present extend over the whole world, have occasionally taken from a place its individuality, from a landscape its picturesqueness. Alas ! Gentlemen, you have made omelets and your engineers sometimes added seasoning, more than was desired. But what is some small corner damaged and some few interests necessarily injured, as compared with the benefits which all humanity owes to your energy and perseverance? What do any justifiable criticisms amount to as compared with the wealth which you have spread in all countries of the world, and with the light you spread over the whole world !

" Well, gentlemen, the Bernese Oberland has at all time looked on railways with favour and it is with impatience that we await the opening of the new lines of the Lötschberg which are now being built, and of the Moutier-Granges line, lines which will very materially improve our communications with neighbouring countries. However the Interlaken railways still leave a good deal to be desired in the Brunig-Lucerne direction, a great tourist centre with which we are only connected by a narrow-gauge mountain-line, a considerable part of it being a rack line. The desire of being connected by a good standard-gauge line with the St. Gothard will always remain an object of our desires.

" But Interlaken has every confidence in the future and it is with a grateful heart that it wishes you good luck by my feeble voice. In saluting your superb work, in bowing respectfully before your fellows, the Bernese Oberland gives welcome to the hardiest, the most beneficent pioneers who, by establishing closer and closer relations between the countries, promote a uniformity of interests among the nations which will tend more than anything else, to make war impossible in the future, by spreading in the whole universe fruitful ideas of justice and peace among a regenerate people ! " (*Applause.*)

Dr. Röll, head of the section at the Imperial ministry of railways, Austria, chief delegate of the Austrian government, vice-president of the session, answered in the following terms :

" Ladies and gentlemen, allow me to express on your behalf a few words of gratitude, simple but coming from the bottom of my heart, to the very amiable welcome with which Dr. Michel has greeted us. From the moment the Congress delegates set foot on Swiss territory, they have, both themselves and those belonging to them, been literally overwhelmed with marks of the greatest attention, with a charming friendliness and an overpowering hospitality. The brilliant programme of receptions organized by the administrations of the Swiss railways for the benefit of the members of the Congress included for today this visit to the Bernese Oberland which is worthily being ended in this incomparable Interlaken. The very distinguished president of the Swiss local committee, Mr. Winkler, thought it necessary, at the opening ceremony, to add to the information he gave us about the proposed excursions, the remark that they would take place whatever the condition of the weather, because even in bad weather the mountains were beautiful ; that is absolutely true, for even if the Jungfrau hides the magic beauty of its majestic forms in the clouds, and if the huge snowfields of the other mountain giants do not reflect the rays of the sun, the view which is offered to our eyes is none the less of a kind calculated to exalt us and overwhelm us at the same time. It is accordingly no wonder that the Congress members have not allowed the bad weather to stop them from undertaking this excursion. The pleasure of tarrying in the bosom of sublime nature is doubled for us by the fact that we can admire its splendours in the company of our Swiss colleagues, and that we can tell them, while under the direct influence of the impressions received, how grateful we are to them for having given us the opportunity of seeing, from so near, one of the most beautiful parts of their

country, so rich in natural beauty, and how happy we are in being able to enter into the most friendly relations with them. The days we have passed here will leave a profound impression in our minds. They will continue to live in our recollection, together with a feeling of gratitude towards all those who have rendered our stay in Switzerland so exceptionally interesting and agreeable. It is with these sentiments that I lift my glass and ask you to drink to the prosperity of the Bernese Oberland and that of its most precious jewel, the beautiful Interlaken." (*Applause.*)

At the *Hôtel des Alpes*, it was Mr. Seewer, president of the municipality of Interlaken, who bid the delegates welcome in the following terms :

" Ladies and gentlemen, I have been charged with the pleasant duty of wishing you a hearty welcome, on the part of the authorities of Interlaken. They are moreover not alone in being delighted with your visit. The whole population of the valleys and villages which you have seen today, or rather which, as you may have guessed, exist in the fog which is hiding them, adds its welcome and its good wishes to those of our authorities.

" I feel it my duty to thank those who are at the head of the administration of the Federal Railway, the Railway Department and the Federal Council, for having thought of our little corner of the country when they arranged the programme of the entertainments to the Congress. We also thank all those who, having to choose between the different excursions provided for them, gave the preference to our district. And we certainly are entitled to a feeling of pride when we see how numerous are the delegates who have given their preference to the Bernese Oberland.

" Ladies and gentlemen, we duly appreciate the honour of your visit of today. Tributaries of international traffic that we are, we fully recognize the enormous power represented by those who manage the transport enterprises, and we know that in our age railways and steamships rule the world.

" Ladies and gentlemen, you are today the guests of a small nation of mountaineers, of simple morals and antiquated habits, but their welcome is none the less cordial. We can show our visitors neither castles, nor monuments, nor sumptuous palaces; our smiling valleys and our beautiful lakes form our wealth and our pride, as also the majestic giants among our mountains, draped in their eternal covering of ice and snow. It is to show you these that we took you today on the lake of Thun, into the charming Lütschinen valley, to the Schynige Platte, to the Scheidegg and from Lauterbrunnen to Mürren, in order to give you a full view of the queen of our Bernese Alps, the always beautiful Jungfrau. But unfortunately Jupiter Pluvius has spoilt both your pleasure and ours. Instead of a blue sky and a brilliant summer sun, we have had rain, mist, snow! Our queen of the Alps has wrapped herself in her thickest veil, perhaps to show her disdain for those wicked men who are bold enough to encircle her august waist with their bands of steel And thus the whole magnificence of our Alps has not been made manifest to your eyes. We can only tell you that we deeply regret this, and we request you to recognize at least our good will, unfortunately or no avail.

" We equally regret that your visit is so short. The happy party now assembled here will soon break up, and its members will once more become dispersed all over the world. But in spite of the bad luck you have had, we venture to hope that you will keep a kind remembrance of us and of our little country.

" It is with this hope that I raise my glass and empty it in honour of our very valued guests. Long may they live! "

This speech was followed by prolonged applause and several delegates expressed the deep gratitude of all taking part in the Oberland excursion, for the very cordial welcome received at Interlaken.

After the dinner the excursionists returned to the Kursaal where a brilliant display of fireworks terminated the day.

Excursion to central Switzerland.
Thursday, 7 July 1910.

Local Lucerne Committee.

President :

Mr. Schmid, manager of the Steam Navigation Company on the lake of the Four Cantons.

Members :

Mr. Dietler, ex-president of the administration of the St. Gothard Railway;
Mr. Ducloux, municipal councillor at Lucerne;
Mr. Fellmann, traffic manager of the Rigi Railway;
Mr. Kolb, traffic manager of the Stansstad-Engelberg Railway;
Mr. Riedweg, innkeeper, president of the Casino Committee at Lucerne;
Mr. von Schumacher, member of the executive Council of the canton of Lucerne;
Mr. W. Winkler, traffic manager of the Pilatus Railway;
Mr. Zingg, president of the administration of the Vth district of the Federal Railway.

Head of the Excursion :

Mr. R. Winkler, manager at the Federal Railway Department.

Assistants :

Starting from Berne : Dr. Bonzon, secretary of the Federal Railway department;
At Interlaken : Mr. Wirth, traffic manager of the Bernese Oberland Railway;
Starting from Thun : Mr. Morgenthaler, manager of the Emmenthal Railway;
At Lucerne : Mr. Schmid, manager of the Steam Navigation Company on the lake of the Four Cantons;
For the 1st group, Rigi : Mr. Fellmann, traffic manager of the Rigi Railway;
For the 2nd group, Pilatus : Mr. W. Winkler, traffic manager of the Pilatus Railway;
For the 3rd group, Engelberg : Mr. Kolb, traffic manager of the Stansstad-Engelberg Railway;
For the 4th group, St. Gothard : Mr. Zingg, president of the administration of the Vth district of the Federal Railway.

It was in a pouring rain, violently driven by the west wind, on Thursday, 7 July 1910, that those taking part in the excursion to Central Switzerland boarded the special train, which was to take them to Lucerne, at Berne at 7.15 a. m.

The run took two hours and a quarter; members read the papers, conversed, discussed the chances of any improvment in the weather, and looking through the windows covered with damp, saw the clouds low down, floating around the fir trees of Entlebuch.

At Lucerne things were as at Berne, and with open umbrella one walked to the quay where two saloon boats of the Steam Navigation Company on the Lake of the Four Cantons awaited the members.

The groups going to Pilatus and to Engelberg both took the direction of Alpnach, while the groups going to the Rigi and to the St. Gothard travelled together as far as Vitznau. The two boats, the *Ville de Lucerne* and the *Schwyz*, were prettily decorated with roses; a cold and seductive collation reanimated the courage of the faint, and it was to the sound of the Bernese march, played by an Italian orchestra, that the members of the Congress, passed in front of the celebrated quays of Lucerne. The green grass and the blue

lake did not — alas — produce their usual bewitching effect.

1st group : Rigi.

At Vitznau, the excursionists forming the first group boarded the carriages of the Rigi Railway. The view hardly extended to 20 metres (66 feet) on each side of the line : here one also saw a muddy torrent, there a cow which looked at one seriously, then a small roadside station, a peasant's chalet, a hotel scarcely visible in the fog.

At noon : « Rigi-Kulm, all change! » One entered the waiting-room of the station, for one could not see the great *Rigi-Kulm Hotel* which is a few yards off; an obliging conductor had to show the way. In a moment the comfortably-warmed rooms of the hotel were invaded; it was a great time for picture postcards. At half past twelve lunch was served, to which everyone of the members did full justice. But a lunch, although accompanied by music and served like clockwork by a battalion of waiters, can not go on for ever. Accordingly after coffee, while some few members, either very courageous or very conscientious, ventured into the fog and went off to the highest point of the mountain, the others, either as actors or as spectators, assisted at the dancing of the youthful.

At 3 p. m., there was a general summons, and the train left at 3.15 p. m. But whereas on the way up, silence had been predominant, the descent was more lively. Nature itself seemed desirous of being less cruel. Rifts in the fog allowed deep gorges and a part of the lake to be seen.

At Vitznau the members again took the boat which delivered them at 5.30 at the *Schweizerhof* quay, where they scattered to the right and to the left in order to visit the interesting town of Lucerne.

2nd group : Pilatus.

In spite of the unpromising aspect of the weather, about forty delegates and thirty ladies took part in this excursion. Groups II (Pilatus) and III (Engelberg) embarked at Lucerne at 9.40 a. m. on a special steamer, beautifully adorned with flags, and went to Stansstad, where the 3rd group left the steamer in order to continue its journey by rail to Engelberg. The 2nd group remained on the steamer and went on to Alpnachstad, the terminus of the Pilatus Railway, after passing under the Aacheregg bridge. The voyage was made pleasant by an ample supply of refreshments and by excellent music.

The Pilatus line, which was built in 1889 with great boldness, is of great interest from the technical point of view. The difference in height between Alpnachstad (440 metres [1,443 feet] high) and the Pilatus-Kulm station (2,070 metres [6,790 feet] high) is 1,630 metres (5,347 feet). The line is 4,610 metres (2 miles 1,520 yards) long; its mean gradient is 38·1 per cent and it steepest gradient is 48 per cent : the run up to the terminus station takes an hour and twenty minutes. The cost of construction amounted to 2,400,000 francs (£96,000).

The station of the Pilatus Railway was beautifully decorated in honour of the excursionists who were musically received by the town orchestra of Alpnach. Several special trains conveyed the guests to Pilatus-Kulm. After passing the interesting Wolfort gorge, the international guests were saluted at Aemsigen Alp by mountaineers, with waving flags, with Alpine horns, and with jodels; the bells of the cattle browsing around completed this Alpine picture. Unterwald girls, dressed in all their native finery, offered the guests tempting fruit. At Pilatus-Kulm the members were able to see the wonderful

view which extends over Lucerne and the Lake of the Four Cantons. Unfortunately the sun did not succeed in piercing the heavy fog, and the majestic summits covered with eternal snow remained invisible. The guests then assembled in the large hall of the *Pilatus-Kulm Hôtel*, richly decorated with Alpine flowers, in order to partake of lunch; during this time the orchestra of the Lucerne *Palace Hotel* made itself heard. Then came, in honour of the international guests, the formal opening of the new gallery called the "Oberhaupt". This interesting gallery connecting the hotel, through the Oberhaupt, with the Pilatus-Kulm Railway station, is cut in the rock and a number of openings are provided, which give magnificent views and where the eye plunges into giddy depths. The work took three years, and the last shots were fired the day before the Congress visit. As the weather was bad, the opening ceremony took place in the hall of the hotel instead of taking place on the spot. It consisted of a theatrical representation. The scenery represented the entrance to the Oberhaupt gallery. The genius tutelary of the mountain, surrounded by artistically-dressed gnomes (represented by children of the employees of the Pilatus Railway), came out of the depths of the gallery, and bade the guests a poetic welcome; the goblins then distributed bouquets of Alpine flowers among the members of the Congress.

This performance was loudly cheered. Although the time for departure approached, several visitors went in for the pleasures of a dance

As the weather had in the meantime improved, most of the guests visited the Oberhaupt gallery, and then left the Pilatus-Kulm at 3 p. m. and proceeded, via Alpnachstad and Stansstad, to Lucerne.

3rd group : Engelberg.

The excursionists going to Engelberg left the boat at Stansstad and boarded the pleasant carriages of the Stansstad Engelberg Railway which were to take them to their destination. The train travelled up the Aa valley, where one ould see at various places the floods which resulted from the last melting snow. Many a member no doubt asked himself whether he would safely arrive at his destination, and whether the impetuous river would not exhibit its destructive powers. There is there certainly a very important subject which the delegates could discuss : " The strengthening of the roadbed of mountain lines running along impetuous torrents subject to sudden and abnormal rises, from the point of view of the safety of the delegates of the Congress, making an excursion on one of those lines ". But there was no need for raising this question. The track, it is true, had been carried away at several points, but it was repaired and nobody thought that he was passing over uncertain embankments or provisional bridges.

Engelberg : " *Alles usstige !* " (All change!) A small walk served as appetizer. The village does not extend very far and in five minutes one arrived at the celebrated convent, but unfortunately its doors were closed.

At this moment it seemed as if the mountain summits wished to become clear. One even saw a beam of sunlight on the snow on the Titlis, and a hope arose : the weather is going to clear up, and after lunch it will be possible to admire the summits covered with fresh snow !

After a comfortable and perfectly-served lunch at the *Grand Hôtel Cattani*, the excursionists went to the church where an organ recital was given in their honour. This performance with its music, sometimes gentle, sometimes reverberating,

made one somewhat forget the thickness and rawness of the air outside.

The concert finished, one left Engelberg, After a run of a few minutes there was a stop coupling on the rack locomotive. The carriage assumed an alarming inclination, for one was on a gradient of 25 per cent. The small locomotive checked the speed of the train, thanks to its good engines, and one arrived without trouble at the bottom of the steep gradient where the locomotive was uncoupled and replaced by a motor car until Stansstad was reached. The excursionists there again met their companions from Pilatus, with whom they returned to Lucerne.

4th group : St. Gothard.

The members of the 4th group left the boat at Flüelen, where a special train awaited them. The large windows of the carriages made it easy to admire the scenery. At Altdorf attention was drawn to the large amount of damage caused by the last flood. From here the valley contracts and soon becomes a wild gorge in which the Reuss forms a roaring torrent. The long series of works by which the St. Gothard tunnel is approached begins; it is a nearly-uninterrupted succession of tunnels, of viaducts, of embankments and of cuttings. As the excursionists penetrated into the mountain, the sky became clearer and clearer until a few rays of the sun reached the rock walls and the summits around them. The lunch at the Göschenen refreshment room was to everybody's taste. During the return, the smiling shores of the lake of Zug were much admired.

* * *

At 6.30 p. m. all the excursionists found each other in the three following hôtels : *Hôtel National*, *Palace Hotel* and *Hôtel Suisse*, where very good dinners were offered to them.

At the *Hôtel National*, Mr. de Schumacher, member of the executive council of the canton of Lucerne, who presided, rose and proposed the following toast in German, in French, in English and in Italian successively :

" Ladies and gentlemen, I have been entrusted, as member and representative of the government of the canton of Lucerne, with the pleasant task of welcoming you here and thanking you for the honour of your visit.

" Switzerland, as compared with most of the States which are represented here, is a small and modest country ; but that does not prevent it from holding its own position in railway development, in following with the greatest interest the questions involved and in taking an active part in their progress. It may well be said that our main lines across the Alps and our mountain railways have engaged the attention of many other countries.

" The International Railway Congress is celebrating its XXVth anniversary. It is no doubt by chance that it is celebrating this jubilee in Switzerland and that some of its members on this occasion are visiting Lucerne. We are grateful for this chance, an we consider ourselves very honoured by this meeting of the Congress on our soil and by this visit which will permanently connect with it the name of Lucerne.

" After hard-working meetings at Berne, you have taken a day of rest and you have devoted it to a visit to Central Switzerland. The weather has been as unfavourable to you as possible and the skies have shown you a persistent ill-humour. They will not yield to the men who wage a continual strife with the natural forces in order to open out, at the cost of a thousand difficulties, the most remote regions and compel them to give room to the locomotive. Is that not a perfectly intelligible feeling ? And that is alone why today the amiable and gracious phalanx of

ladies throws a ray of light into this dark picture and warms up all hearts.

" It is more especially to you, ladies, but also to you, gentlemen, that I address my wish of welcome. I thank you for your visit and I raise my glass to your health and to the prosperity of the Congress."

Mr. COLSON, of the Permanent Commission of the Congress and member of the *Institut de France*, answered in the following terms :

" Ladies and gentlemen, the Permanent Commission of the Railway Congress has given me the pleasant task of today thanking in its name our hosts, to whom we are indebted for our very pleasant stay in Switzerland. And in the first place I wish to address all our thanks to the authorities of the canton and of the town of Lucerne for their gracious welcome, and to their representative Mr. von Schumacher for the very flattering words he has just pronounced.

" We have today been conducted and entertained by the Swiss Organizing Committee, and we have seen the programme it had drawn up carried out with that faultless regularity to which it has accustomed us, and which is so essential and at the same time so difficult to attain. It received the disinterested assistance of the local transport enterprises, of the steamship companies and of the Rigi Railway Company, whom we also all wish to thank. So excellent was the organization and so good everybody's humour, that in spite of the bad weather, we have had the opportunity of passing a very pleasant day.

" Ladies and gentlemen, as I am today representing the Congress, I would like to say in its name how happy we all are to find ourselves among the Swiss people during this session. The modern development of transport has not led only to meetings for considering special questions, such as ours. The extension of relations between nations, which it has made possible, has resulted in the creation of a large number of international bodies intended to promote agreement on innumerable questions affecting the interest of many and various peoples. Some of them have taken the form of bureaux instituted by diplomatic agreement between governments; others are the work of private initiative, ensuring the periodic meeting of the most important of the innumerable congresses held to promote the progress of art, of science, of industry, or of the most varied institutions. Such bodies choose as their domicile two countries small in extent, but great in their action in the world, which their neutrality places outside the rivalries unfortunately inevitable between States called upon to play a more militant part, namely Belgium and Switzerland. In each of them, everyone is accustomed to find a friendly reception, under the influence of which amicable relations become developped and intercourse becomes easier and easier among all.

" As for us, the International Railway Congress, which is a private institution, as the States only stand in our association on the same footing as the private companies, we have our regular domicile in Belgium. But we are happy that one of our periodic meetings has brought us to the other international centre, and deeply grateful for our welcome in Switzerland.

" And as it is to a Frenchman that the distribution of the functions of the Permanent Commission has given today the honour of speaking in the name of all the peoples taking part in the Congress, he may be alloved to add, in the name of his own country, the expression of the high importance he attaches to the excellent relations which have existed for so many years between him and his Swiss neighbours, and to the cordial understanding arrived at in our days between the railways of the two States, an understanding strengthened recently by a treaty for the joint carrying-out of works for the development of international traffic.

" Ladies and gentlemen, in the name of the Railway Congress, I propose to you the health of the town and of the canton of Lucerne, and of the Swiss people! "

At the *Palace Hotel*, the seat of honour was occupied by Mr. Theodor Schmid, mayor of Lucerne, who welcomed the guests in the name of the cantonal and the municipal authorities of Lucerne in the following terms :

" Ladies and gentlemen, in the name of the authorities of the canton of Lucerne, I wish you a cordial welcome to the shores of the Lake of the Four Cantons. You have interrupted your laborious work today in order to pay a visit to Lucerne and to Central Switzerland. We thank you for this honour, which we all fully appreciate. We only regret that your excursion was not more favoured by the weather.

" We would have taken you with pleasure, on a hot July day, to the pure air of our mountains. With what pleasure would we have made you admire, in bright sunlight, the majesty of the Alpine chain, the giants of the mountains with their silver summits, the green pastures, the superb lakes, the classical sites of Central Switzerland! But we were denied this pleasure.

" Our mountains were enveloped in thick mist, the rain fell in torrents. You have even found fresh snow on Pilatus in the middle of summer!

" I venture to hope that later on you will return to Lucerne and to rural Switzerland under more favourable auspices, and that you will then take away with you a better impression than will be the case today.

" The sketch which is shown on the menu of your dinner opens out the prospect of the possibility of undertaking an excursion through the air.

" Ladies and gentlemen, foreigners come to us every year in hundreds of thousands in order to seek rest and to admire the natural beauties of our country. It is essentially to the improvement of travelling methods that we owe this great growth in our visitors. At all times have civilized people considered the improvement of the ways of communication as of capital importance. It is in particular the construction of railways which made an enormous advance possible in this way, a whole transformation. All countries, all nations work in a spirit of noble emulation at the completion of their railway systems, at the improvement of their communications, at facilitating their traffic.

" You will no doubt have remarked that our little Switzerland also has during the course of the last *lustra* completed a fine piece of work. I refer to the piercing of the Alps, by the St. Gothard tunnel, the north entrance of which some of you have visited today. I recall the construction of the Simplon line, which like that of the St. Gothard, is intended to draw closer together the bonds between the countries north and south of the chain of the Alps.

" There must necessarily be a certain uniformity in the construction and the operation of railways and it is the great object of the Congress to promote this uniformity. For the last twenty-five years, the most important representatives of the railway world have been working at the solution of this important question, and we owe almost every valuable step in advance to their disinterested activity.

" I conclude by raising my glass to the always-growing activity of the International Railway Congress! "

Dr. Ulbricht, professor, member of the Permanent Commission of the Congress, councillor of the Saxon ministry of finance, answered in the following words :

" Ladies and gentlemen, you have just heard the friendly words of welcome with which the representative of the canton of Lucerne has greeted us in the name of the cantonal and the municipal authorities, and his appreciation of the importance of our Congress. It is to me that the undeserved honour has come to thank him for his words, as well as for the friendly reception we have had today I of course do so with pleasure and with all my heart, certain as I feel of being able to count on your unanimous support.

" Ladies and gentlemen, when we started

this morning in heavy rain, no doubt we all asked ourselves this disquieting question : " In " what state shall we return tonight ? " And, now, we can answer it in a most consoling way. Thanks to the excellent arrangements prompted by a spirit of generous hospitality, which we owe chiefly to the canton and the town of Lucerne, we find ourselves here assembled together, after our so-well-organized excursion, in a most happy frame of mind. This reminds me of a reflection of the good peasant to whom some one was praising the sun. " That the sun is shining in " broad daylight, that is not surprising. But " that the moon appears at night — well, that is " really remarkable ! " And so we can say, on this day of rain : " To organize an excursion " into the mountains on a fine day, so that the " members enjoy it, that is easy. But to " organize it in such a way that even in such " awful weather everybody is pleased — well, " that is really remarkable ! "

" We are here assembled on the hospitable soil of the canton of Lucerne, after our hard-working meetings, and have the agreeable feeling of no longer being divided into sections and strictly grouped without distinction of nationality. We cannot, it is true, eliminate national differences and political frontiers ; nor do we desire to do so, for we should then eliminate at the same time an important factor in progress, namely competition between nations. But as regards the international relations of railways, we can extend our hands to each other across the frontiers, and as regards the functions and the work of our Congress, we can here, on the shores of the Lake of the Four Cantons adopt with our Swiss colleagues the device of Wilhelm Tell : " We will be but one nation of " brothers ! "

" We owe it to the generous hospitality of our Lucerne friends that we can indulge in these happy feelings and let ourselves be permeated by them.

" Let me express all our gratitude for the kindnesses we have received on Lucerne territory by these few words : " Cheers for the " canton of Lucerne ! Cheers for the beautiful " city of Lucerne ! "

Finally at the *Schweizerhof* it was Mr. Steinmann, councillor of State, who welcomed the members :

" Ladies and gentlemen, I have the honour, in the name of the government of the canton, to bid you a cordial welcome.

" We are delighted that an excursion to Lucerne and to Central Switzerland was included in the programme of the International Railway Congress. I therefore thank you, in the first place, for the honour you have done our canton and its capital, the city of Lucerne. We are proud of being able to greet within our walls, even though but for a short while, a meeting so important to the development of railways. In particular I wish to welcome the ladies who, although fulfilling no official functions, favour our assembly with the charm of their presence.

" Gentlemen, you may feel certain that your work of developing the railways will nowhere meet with more sympathy than in Lucerne, the international metropolis of the hotel industry, as well as in our whole canton and in Central Switzerland generally.

" Ladies and gentlemen, let me give you an instance of that sympathy with which our people and our authorities regard you : it is the fact that Lucerne, as a central point of the tourist traffic, not only gives work to five lines of the Federal Railway, but also to seven mountain railways. Among these lines, those of the St. Gothard, the Rigi and the Pilatus are considered masterpieces in the way of railway building. The canton of Lucerne has also had the honour of possessing the first mountain line of any importance, that of the Rigi, which has served as model and of which I do not wish to speak without recalling the memory of the great engineer Riggenbach. We also have the honour of including among our citizens another authority on the subject of mountain railways, namely Mr. Romain Abt, the inventor of the system known by his name.

" The functions of Lucerne in the matter of the tourist traffic make it necessary to develop its means of communication in every way. It is thus that side by side with our well-managed railways and with our well-managed steamships which plough our beautiful lake of Lucerne, we will soon have a station of dirigible balloons, the first in Switzerland; side by side with communication by water and by earth, there will be communication by air.

" I think I have now demonstrated to you that Lucerne does not lack intelligence in developing its means of communication, as required by modern times, and that it is ready to face any expenditure that may be necessary. I cannot refrain, on this occasion, from speaking of our hotel-keepers, who work with energy and decision at the continuous development of our ways of communication and devote considerable sums to do this.

" Lucerne thus knows what it owes to the men who have devoted themselves to the work of paving the way, by holding meetings, for the improvement of the international railway traffic; for railways are the chief means of communication.

" Ladies and gentlemen, we have unfortunately not been able to show you the beauties of our country in all the splendour of a sunny day. Nevertheless we hope that you will take home with you a good remembrance of this excursion in our little country. May our mountains, our lakes, our valleys, our hills, our historic sites dear to every Swiss heart, always recall to you our Swiss fatherland, and may you especially keep a good recollection of our Lucerne. May the white cross on a red ground, that federal cross which is today decorating all your breasts, recall to you, each time that you see it in your distant countries, a vivid recollection of our peaceful valleys and of your excursion to Lucerne.

" What we hope today is, that in the future there may always be men of science who will devote their time and their work to the development and improvement of ways of communication, more especially railways, in the interests of the prosperity and well-being of all countries.

" It is in that spirit thas I invite you to raise your glasses and drink to the success of the work undertaken by the International Railway Congress ! "

Mr. DE GEDULY, manager of the Hungarian State Railway, returned thanks in these terms :

" Ladies and gentlemen, you will kindly allow me, as vice-president of a section, to answer in your name all the friendly wishes of welcome which have just been addressed to us, and to express our deep and sincere gratitude for the superb reception we have enjoyed today. Our thanks are due in the first place for the Swiss hospitality, for the generosity of the Confederation, of the canton and of the city of Lucerne; it also is due to the very kind administrations of the railways and steamships and especially to our Swiss colleagues, who have worked so hard and so amiably for us.

" A good many years ago, I was at a banquet in Bosnia. And the mayor — a Turk — expressed in his picturesque language his regret that his body was not of glass, so that his guests could see in his heart how he loved them. I think that we could repeat that wish. We, the guests of Switzerland, we would wish at this moment that our bodies were transparent, so that our dear colleagues could read in our hearts. They would find there our deep gratitude, they would convince themselves of our warm sympathy, and they would see that we are filled with admiration for Switzerland and for its institutions.

" Switzerland ! The name alone already made our hearts beat in the days of our youth, and in the course of years, our sincere enthusiasm for the majesty of its natural beauties and for the work of its inhabitants has but increased. There is no doubt that it was in one of his happiest moments that the Lord created this country on which he has bestowed a special affection !

" We all, who have come from all the countries of the world, we admire its snowy summits directed heavenward, its glaciers, its deep

gorges, its lakes of smiling, but occasionally treacherous, waters, its green pastures and its forests; the hospitable appearance and the picturesque charm of its habitations.

" And between these imposing mountains, on the shores of these lakes, there dwells an energetic nation, of upright spirit, whose love of liberty and thirst for progress form its noblest qualities. This nation at all times has had the rare happiness of possessing men who managed its government in a remarkable fashion, but the groundwork of its constitution has been, and still is today, the principle that the people govern themselves. But one particular favour which divine Providence has bestowed on this small nation has been to give them a number of distinguished engineers who have made it possible to conquer the immense difficulties which nature opposes to ways of communication and especially to railways; it is they who with inventive talent and iron will have overcome all the obstacles found in their way, and who have earned the gratitude of the whole world for the boldness of their inventions and for the improvements they have made in the domain of ways of communication.

" Today we have had the opportunity of admiring many of these masterpieces of civil engineering, and the engineers of all countries can warmly congratulate their Swiss colleagues on their fruitful labours.

" Mr. Steinmann has expressed his regrets that the sun did not shine on us today. But let me record that if the sun did not shine in the heavens, the sun of Swiss hospitality has today shed on us its most brilliant light.

" Ladies and gentlemen, I request you to raise your glasses to the prosperity and happiness of the Confederation, of the canton and city of Lucerne, of the railway and steamship administrations, to the health of our excellent and charming Swiss colleagues! Long may they live and prosper! "

All these speeches were much applauded.

After the dinner, the members of the Congress directed their steps to the station, passing through the town of Lucerne which was brilliantly illuminated in their honour; at 9.30 p. m. they boarded a special train which took them back to Bern, Thun and Interlaken.

Excursion to Lausanne-Montreux. Tuesday, 12 July 1910.

Local Lausanne-Montreux Committee.

President :

Mr. C. Decoppet, State councillor, at Lausanne.

Members :

Mr. Barraud, manager of the Lausanne tramways;
Mr. Chatelanat, syndic of Veytaux;
Mr. Chessex, proprietor, at Territet;
Mr. Emery, State councillor, syndic of Châtelard;
Mr. Lacombe, manager of the General Navigation Company on the Leman lake;
Mr. Miauton, syndic of Planches-Châtelard;
Mr. Schnetzler, syndic of the town of Lausanne;
Mr. Stockmar, president of the administration of the 1st district of the Federal Railway;
Mr. Tschumy, innkeeper at Ouchy.

Head of Excursion :

Mr. Sand, member of the general administration of the Federal Railway.

Assistants :

Starting from Berne : Mr. Dinichert, secretary at the political Federal Department;

Starting from Interlaken-Thun : Mr. Wirth, traffic manager of the Bernese Oberland Railway;

Starting from Lausanne : Messrs. Decoppet, State councillor; Lacombe, manager of the General Navigation Company on the Leman lake; Schnetzler, syndic of the town of Lausanne.

The members of the Congress who took part in the Lausanne-Montreux excursion will say that our celebrated Montaigne is for once wrong when he says " the pleasures and good things that we have, there is not one which is not alloyed with some evil and some inconvenience ! "

The whole day was beautiful and the rain, that celebrated rain which was an especial feature of the eighth session of the Congress, did not arrive till the evening, just in time to make the visitors admire the marvellous play of colours the lake of Geneva can produce.

The excursionists, leaving Berne by special trains, arrived at 11 a. m. at Lausanne, where the State council of Vaud and the municipality of Lausanne, with Swiss simplicity and cordiality offered them some welcome refreshments at the Lausanne-Ouchy casino. Flowers were very kindly presented to the delegates and their ladies by a number of charmingly dressed young girls.

At noon, special tramway cars, kindly supplied by the Lausanne Tramway Company, conveyed the excursionists to the three large hotels of Ouchy : *Beau-Rivage*, *Château* and *Royal*, where an excellent lunch was served. The delegates appreciated, as connoisseurs, the special wine grown in the vineyards which are the property of the town; this wine was presented by the municipality of Lausanne.

Mr. Robert Comtesse, the president of the Swiss Confederation, was present, also Mr. Deucher, federal councillor, and representatives of the federal courts, of the State council of Vaud, of the local authorities, of the management of the first district of the Swiss Federal Railway, etc.

The Lake Geneva Navigation Company then invited the delegates to embark on the ships *La Suisse* and *Montreux*, and to go on the classic round of the upper lake by Evian, Bouveret, Vevey, and then on to Montreux. At the start, the delegates passed through two rows of little girls dressed in white and of cabin-boys with long oars. Cordiality reigned on board the ships and the sun, which wanted to see the company, showed up the natural beauties of this wonderful country.

At the Montreux landing-stage, the delegates were received by the local authorities while the town band made itself heard.

Most of the delegates then went to Glion, taking advantage of the facilities granted by the companies operating the Vevey-Montreux, the Montreux-Glion and the Territet-Glion lines.

At Glion, the view was a magnificent, extending from Geneva to the « Dent du Midi », which stood in its majesty and was quite clear, and received unbounded admiration. The Rochers de Naye and the Jaman appeared in their full beauty.

At 7 p. m. the excursionists sat down to the dinners given at the *Montreux Palace* and at the *Grand Hôtel* of Territet. The food was excellent, the wines were delicious, there were excellent orchestras and the floral decorations were magnificent.

At dessert Mr. Emery, the syndic of Châtelard-Montreux, welcomed the delegates in the following words :

" Ladies and gentlemen, one of our most illustrious masters of gastronomy, Brillat-Savarin, has said that a dessert without cheese is like a fair lady who has an eye missing.

" One might add, particularly in these days,

that a dinner without speeches in an imperfect dinner, although I very much fear that the side-dish which my duties as syndic oblige me to offer to you runs the risk of being indigestible. But the speaker who will succeed me will compensate for the lack of my eloquence.

" Ladies and gentlemen, allow me, in the name of the Montreux authorities, to wish you all a cordial welcome and to thank the organizers of this Congress for having included Montreux in today's excursion.

" But allow me also to tell you how disappointed we are and how much we regret that the time you can give us is so short.

" Montreux is not a large place; nevertheless a few hours more would have given you the opportunity of appreciating it more.

" Montreux, as you know, in a tourist resort. That is to say, that the hotel industry plays an important part here. Now it is indisputable that the railway industry and the hotel industry have numerous points in common. You have sleeping cars and dining cars which are nothing but hotels on wheels. Ours are stationary. Just like you, we have continually to improve our installations, we have to keep up to the level of modern requirements and of modern inventions. Thus we both strive for progress. There is one point, however, on which we have not been able to agree, and that is whether it is the railways which bring us the travellers, or whether it is the hotel which attracts the travellers.

" As for me, I think that each has its well-defined function, within its own limits; that these two industries snpplement each other, and that our many mutual interests oblige us to advance hand in hand.

" We will however readily admit that without railways many hotels would no longer have any reason for their existence and would have nothing further to do, except to shut up.

" You will no doubt have noticed the chain of mountains which protects us against the north wind. It is to this natural protection that Montreux owes its reputation, and it is therefore considered a winter resort, and it has been called the Nice of Switzerland; and that is why, when the season is in full swing everywhere else, you will find Montreux like a house abandoned by its masters and its usual guests; and it is this which has prevented it from assuming its most festive garb in order to receive you.

" Nevertheless we hope that you will take away pleasant memories of this short visit here, and whenever it pleases you to see Montreux again, in spring, in autumn or in winter, we will always be happy to receive you.

" Ladies, it is exceedingly pleasant and agreeable to us, whatever our age, whether we are in the hey-day of spring, or whether winter snows have powdered our heads, to wish you welcome and to thank you for having honoured and beautified this dinner with your presence.

" Gentlemen, I express the best wishes that your future conquests in the domains of railways may continue, on your symbolic winged wheels, to progress with every improvement. I raise my glass in honour of the members of the eighth session of the Railway Congress." (*Applause.*)

Mr. Petri, councillor of the Imperial Ministry of railways of Germany, vice-president of the eighth session of the Railway Congress, replied in German in the name of the delegates to Mr. Emery, as follows :

" Ladies and gentlemen, in my capacity of delegate to the Congress, allow me to thank Mr. Emery, the syndic of Montreux, for the very friendly words of welcome which you have just heard.

" The eagerness with which Switzerland undertook to organize the eighth session has been a great gratification to our Association.

" This is proved by the large number of delegates who have come, and all will say that we have come full of liking for Switzerland, that country where there is as much to learn as to admire.

" The special conditions obtaining in this wonderful mountainous country are such that the railway engineer has found vast problems

there, and it is in their strife with the gigantic world of mountains that the Swiss railways have shown their best powers.

" It is with admiration that we look at the energetic Swiss nation under a beneficent government, which has attained an astonishing degree of perfection.

" We are equally full of enthusiasm over the enchanting natural beauties of this blessed land, and the delightful days passed during the eighth session will continue to dwell in the memories of the members.

" These days have acquired a special value, owing to the captivating amiability and kindness with which the representatives of this dear country have striven to receive us, to increase our welfare and to make our stay in this beautiful and hospitable country as happy as possible.

" Today's excursion is yet another proof of this. The authorities of the canton of Vaud have overwhelmed us with their very cordial reception in their delightful country.

" Gentlemen, I express the sentiments of all in addressing to you our warmest and most sincere thanks, and I raise my glass to all those who have received us so cordially in this dear country : long life to them ! " (*Applause.*)

While these friendly words were exchanged at Montreux-Palace, Mr. Miauton, syndic of Planches-Châtelard addressed the following speech to the delegates at the *Grand Hôtel* at Territet :

" Ladies and gentlemen, in our time of quick social evolution, official duties would be a heavy burden if they did not sometimes bring happy rewards to those charged with them.

" As for me, syndic of Montreux, I fully appreciate the value of the agreeable duty which has today fallen upon me, of bidding you all welcome in the name of our beloved city.

" Montreux is having a festival.

" Montreux is happy and proud.

" It is to your presence that it owes this joy.

" It is to the Federal Council that it owes this honour.

" Nothing could gratify us more.

" May I therefore be permitted to express here, our gratitude to the Federal Council.

" Ladies, may you be welcome, you who know, by your charming grace, how to temper so usefully the severity of our preoccupations.

" You are the bright spots in our lives. To please and to charm are your divine privileges which society respects, but which nature alone has given to you.

" And if you have come to the country of the narcissus, that sad flower with the sweet smell, in order to reflect your charming images in the waters of our lake and conquer all hearts, your mirrors, ladies, are too faithful and already all our hearts belong to you, with but one exception, my own, which you will allow me to except out of discretion, firstly because it is too old to be of any value, and because an honest man is not allowed to give away something which no longer belongs to him. No, you have come because you had duties to perform towards the delegates, remembering no doubt that antiquity did not wish that a man should wear himself out by excessive work. Perhaps also out of pure curiosity, in order to see, to learn, to travel, thus illustrating by a very happy action one part of the usefulness of the work of the members of the Congress.

" Gentlemen, may you also be welcome, you who in the intervals of your useful labours, and in order to find a temporary rest from your creative work, come to the foot of these high mountains whose high summits ignorant of the powers of mankind seem to hurl a defiance at you.

" Welcome to you, the greatness of whose work, the legitimate privilege of the chosen few, is only equalled by the loftiness of your ambitions and of your immovable will.

" Welcome to you who know, by the genial association of your nations, how to place the universal well-being above individual interests; how to reduce the vicissitudes of the fortune of the world by the community of interests, and how to create reciprocal friendships between different countries.

" By your conceptions and your works, which bestow on you a large fraction of the economic sovereignty, you raise labouring mankind, releasing from their social prison millions of workers, otherwise mostly victims destined to misery and to starvation.

" It is this steel network, an admirable instrument of influence and of power, whose meshes, every day coming closer together, envelop millions of beings occupied, like you, in passing through this life, which makes you the determining cause of the modern industrial activity. You peacefully prepare future fates, by bringing truth, wealth, science and life to the remotest corners of nature.

" By your struggle, always more intense in the midst of the continually-growing requirements of our modern society, a perpetual manifestation of energy of which your Congress is the expression; by the clear foresight of future possibilities and of duties which your ideal imposes on you, you ensure that peaceful but freedom-bringing revolution from which universal brotherhood will emerge triumphant for all.

" I conclude in expressing the hope that we will again see you with us. Montreux, a small city in the small country of Switzerland, itself a small country as regards the number of its inhabitants, but a great nation in its ideals, hospitable Montreux is grateful to you for the honour you have bestowed on it. In the name of the whole population, once more, I thank you." (*Applause.*)

Mr. KAREISCHA, assistant manager of the traffic department of the ministry of ways of communication of Russia, principal secretary of the 3rd section of the eighth session, replied to Mr. Miauton, the syndic, as follows :

" Ladies and gentlemen, allow me, in the name of the delegates of the Congress, who have met from different parts of the world, to offer our most sincere and most cordial thanks to the Swiss organizing committee, to the cantonal and communal authorities and to the administrations of the different transport establishments and enterprises, for the friendly welcome we have had in your beautifuf country and in the canton of Vaud.

" I therefore raise my glass to the prosperity of Switzerland and to the good health of the authorities mentioned, as well as to the good health of the inhabitants of beautiful Territet! " (*Applause.*)

Mr. PETSCHKOVSKY, engineer of bridges and roads, chief engineer of the traffic department of the Russian South Western Railway, then added the following words :

" Ladies and gentlemen, tonight we arrive at the end of the series of marvellous excursions which have been organized for the delegates of the International Railway Congress. The recollection of the splendid and cordial welcome which we have received in Switzerland will always remain engraved on our grateful hearts. As delegates of railways, we know from experience, what difficulties the reception of such a large number of guests involve and how much extra work this entails on the operating staff. We are at the same time quite competent to appreciate with what skill everything has been organized. I have been amazed at all I have seen, especially at Berne station where all was concentrated. The regularity and the coolness with which the employees carry out their duties in the most difficult and unforeseen cases have very much struck me and have increased my profound respect for the discipline and the intelligence of the employees. With such a staff the Swiss railways are sure of their future and of the continuation of their prosperity.

" In witness of my profound gratitude, I raise my glass in the honour of all the employees, of whatever rank, of the Swiss railways : *Vivant, floreant, crescant!* " (*Applause.*)

The delegates finally went to the Montreux *Kursaal*. The town was decorated and illuminated. On the public places a

flourish of trumpets was heard. Inside the *Kursaal* the orchestra played its finest music to perfection and was much applauded.

But the hour for departure was striking. Too soon, alas, and not without regrets, did the delegates part from Montreux and from the Vaud authorities in order to resume the homeward journey by special train.

This excursion to Lausanne-Montreux was, in the opinion of everybody, most successful and the members taking part in it will certainly never forget it.

Excursion to Zurich, Tuesday, 12 July 1910.

Local Zurich Committee.

President :

Mr. Bertschinger, president of the administration of the district III of the Federal Railway.

Members :

Mr. Bleuler-Hüni, State councillor, at Zurich;
Mr. Bitterli, manager of the Oerlikon works;
Mr. Brunner-Vogt, president of the administrative Council of the Steam Navigation Company on the lake of Zurich;
Mr. Koch, manager of the wagons works, at Schlieren;
Mr. Dr. Müller, legal adviser to the town of Zurich;
Mr. Neithardt, president of the Development Society of Zurich;
Mr. Nüscheler, traffic manager of the Uetliberg Railway;
Mr. Schoop, member of the administrative Council of the Dolder Railway;
Mr. Studer, manager of the Zurich tramways;
Mr. Zoelly, manager of the Escher, Wyss & C° works, at Zurich.

Secretary :

Mr. Dr. Schumann, secretary of the administration of district III of the Federal Railway.

Head of the Excursion :

Mr. Robert Winkler, technical manager at the Federal Railway Department.

Assistants :

Starting from Berne : Mr. Dr. Bonzon, secretary at the Federal Railway Department.
Starting from Interlaken-Thun : Mr. Wirth, traffic manager of the Bernese Oberland Railway.
For Zurich : Mr. Bertschinger, president of the administration of district III of the Federal Railway.
For the 1st group, Dolder : Mr. Schoop, member of the administrative Council of the Dolder Railway.
For the 2nd group, Uetliberg : Mr. Nüscheler, traffic manager of the Uetliberg Railway.
For the 3rd group, Schlieren : Mr. Koch, manager of the Schlieren wagon works.
For the 4th group, workshops of the Federal Railway : Mr. Bertschinger, president of the administration of district III of the Federal Railway.
For the 5th group, Oerlikon : Mr. Bitterli, manager of the Oerlikon works.

The delegates and their ladies who preferred the banks of the Limmat to the shores of the Lake of Geneva, left Berne by special train at 9 a. m., about three hundred and fifty in number.

The sun was not sulking and its bright rays put everybody into a good temper during the journey from Berne to Zurich, while one quickly passed the substantial

Bernese farmhouses with their great arched roofs, the factories with clear windows and high chimneys, the workmen's dwellings and the private houses which all show the desire of the architect to combine local styles with the most modern comforts. While the " steam-men " talked " compounds " and " superheating ", the electricians complacently drew attention to the high-tension electric-supply lines which run across the country and which " threaten " or " will finally replace " the steam locomotive. These subjects did not seem to have any interest for the ladies, whose attention was more attracted by the chocolate and the soap factories, the dye works and the weaving mills, then by Schinznach Bad, the castle of Habsburg and Baden-les-Bains.

On arrival at Zurich at 11.20 a. m., the different groups of excursionists separated according to their respective destinations.

1st group : Dolder.

The members forming the first group took the Dolder Railway, which is an electrically-operated cable line, going up the slopes of the Zurichberg. This line is 800 metres (875 yards) long, and has gradients of from 95 to 177 per mil. At Dolder station, which is 600 metres (1,968 feet) above sea-level, the members admired the magnificent panorama which presented itself to their eyes.

A feeling of well-being came over the delegates as they approached the Dolder, which is surrounded by a park with charming glades, with terraces around the building, which is in the midst of verdure and of flowers.

The appetites were sharpened by the fragrance of the forest and it was with a feeling of gratitude to the organizers that the guests entered the *Grand Hôtel du Dolder* and took their places at a table prettily decorated with small red roses, a charming decoration in perfect taste. An excellent orchestra added the pleasure of hearing to the pleasure of the sight, and contributed to the gaiety of the guests.

2nd group : Uetliberg.

The members of the 2nd group boarded the blue and white cars of the Zurich tramways which took them to the beautifully-decorated station of the Uetliberg line. Two trains, also adorned with flowers, soon took them up to the summit of the Uetliberg. The standard-gauge line has a length of 9·13 kilometres (5 miles 1,185 yards), and gradients of up to 7 per cent; the difference in height between the two ends is 600 metres (1,968 feet). It first passes through the suburbs of Zurich, and then goes through meadows and orchards to enter the forest, which covers the upper parts of the mountain.

Lunch awaited the visitors at the *Uetliberg Hotel*. The visitors at once took their seats, and at the psychological moment when the company was ready to hear something well said and delicately thought out, Mr. Mauris, director of the Paris-Lyons-Mediterranean Railway Company, gracefully pronounced the following speech :

" Ladies and gentlemen, I feel confident that I interpret your wishes and act in accordance with the general feeling, in expressing our lively gratitude to the organizers of the charming entertainment which has been graciously offered to us today and at which we are now present.

" The Swiss authorities, our colleagues and friends of the Federal Railway, and the representatives of the private railways have provided and arranged everything with a view to amusing us and charming us, to make us appreciate the charm and the beauty of their wonderful country, under many different and varied aspects,

laughing or magnificent. They have known, judiciously, how to break the dry work of the Congress by interesting visits to industrial establishments, or by excursions where everybody could satisfy his taste and his bent. They have thus combined the agreeable and the useful, and they have added to their kindness by graciously inviting our families also to benefit by the facilities which have so generously been granted to us.

" We are grateful to them for their kind and delicate attentions. They have in succession shown to us their smiling valleys, their pinnacles covered with the eternal snows, their glittering glaciers, the lofty summits of their mountains; in short all that forms the attraction of this incomparable country. We have just enjoyed, while ascending the Uetliberg, the magnificent panorama afforded by the Lake of Zurich and by the city nestling on its smiling shores. We shall take away with us an exquisite and ineffaceable recollection of our stay in Switzerland and of the warm welcome we had there.

" Our special thanks are due to the Uetliberg Company which has given us such a hospitable reception, and to its manager who has kindly acted as our guide in our charming excursion. Formerly mountains were an obstacle which repelled travellers. Today they tempt him and attract him, thanks to the remarkable works constructed by the Swiss engineers who have cleverly known how to hang their bold lines to the walls of mountains, and build railways to summits which could formerly only be reached by hardy climbers, but are now within the reach of all.

" I see with pleasure that we have among us a large number of ladies and of younger girls who are accompanying their husbands and their fathers. Their presence adds a charm to this assembly and gives it more life and gaiety. I am sure, gentlemen and dear colleagues, that I express your sentiments in raising my glass to their health. I drink to you, ladies, whom we have today the great pleasure of seeing around these tables."

These words were followed by prolonged applause.

The excursionists then went to the " Kulm ", which is surmounted by a sort of " extra Kulm ", in the shape of a high iron tower. That " extra Kulm " was not to everybody's taste, for the unobstructed view obtained from the top of it is only obtained at the cost of a laborious ascent, while one can see the same view without trouble in successive sections, by walking round the walls. More than one excursionist no longer recognized the Zurich which he saw ten or twenty years ago from the same Uetliberg. The town has pushed out its tentacles in every direction and all those new roofs on the shores of the lake and on both sides of the Limmat give one the impression of a busy hive and of a town which is booming. In the south one sees the Alps, a little screened by disturbing wisps of clouds, and the foreground is a mass of rich green formed by woods, by meadows and by orchards covering beautifully-undulating country. This green is unreal, one delegate remarked who had just come from the burnt country of Algiers.

The hour and the place promoted friendly intercourse and it was with regret that the members took the return journey to Zurich. The same bright clear blue and white cars took them through the streets of the city. The ladies quickly purchased the usual souvenirs and met again at the Tonhalle, which was magnificently decorated for a grand dinner.

3rd group : Schlieren.

The delegates forming the 3rd group met at 11.30 a. m. at the *Hôtel Victoria*, Zurich, where an exquisite lunch was served on small tables. The special train which conveyed them stopped at Schlieren in the middle of the works, for the car works are

in the immediate neighbourhood of the station, with which they are connected by a private branch track. This establishment, which was started in 1902 on a very modest basis, now covers a surface of 12 hectares (29·65 acres), and about a thousand men are now employed there. Its stores of timber are remarkable and represent an average book value of about 800,000 francs (£32,000).

The members were conducted by Mr. Koch, the manager of the works, and by Mr. Kamber, his assistant, who graciously placed themselves at the disposition of the excursionists and showed them successively many wagons of the Federal Railway, tank trucks, cars for the Tramvie luganesie, and for the Chaumont Cable Railway (near Neuchâtel); all the seats of these were arranged on platforms, on a new plan, looking downwards and thus allowing the view to be enjoyed. All these cars were shown in the various successive phases of their construction. Among the details inspected, we may mention two patent devices for preventing fingers from being caught between the hinges, ingenious locks used on the Swiss wagons, installations for autogenous soldering, an automatic fire-alarm and fire-preventer and a large number of other things of equal interest. The delegates then visited the locksmith's shops, the carpenter's shops and others, all equipped with most up-to-date appliances; also the stores, the organization of which was admired by the specialists.

The last part of the visit was reserved to a demonstration of the installations made for the transport of wounded soldiers, which are adopted to two hundred carriages, with three axles, of the Federal Railway. It was with the greatest interest that the excursionists admired this installation, but each of them expressed to himself the wish that it may never be necessary to transform these carriages into ambulances.

Refreshments kindly offered by the works concluded the visit, and it was with their best thanks that the delegates parted from their hosts of the last two hours and returned to Zurich.

4th group : Workshops of the Federal Railway.

Soon after the arrival at Zurich, sixty ladies and gentlemen forming the 4th group met in the dining-room of the *Hôtel du Saint-Gothard*, superbly decorated with roses and with flags of the national colours, where an elaborate lunch awaited them, which took nearly an hour and a half; then a special train conveyed them, together with twenty others who had lunched at the *Hôtel Victoria*, to the new workshops of the Federal Railway. While a small fraction of the excursionists was taken in motor cars to the goods yard, to examine the installations there, the rest of them strolled about the workshops, assisted by a small plan of which each had received a copy, The car workshop is not yet completed, the building only is finished; the inside fittings are still missing in the framework which is to contain the dining-hall and the baths. On the other hand, the locomotive section is in full swing; the excursionists examined it in detail, as well as its annexes, which include the transformer substation, the forge, the shop for turning up the wheels, the boiler house and the stores. The workshops are more particularly devoted to the maintenance of the rolling stock of district III, and at present look after :

308 locomotives, including tenders;
874 carriages;
175 luggages vans;
2,247 wagons.

The delegates then visited with much

interest a small exhibition including a locomotive with Stumpf valve gear, an express locomotive with Brotan boiler and a carriage electric-lighting installation, on the Brown, Boveri & Co. system. The electric accumulator locomotive of the connecting line to the slaughter-houses excited great interest among the technicians. At 3 p. m. this locomotive took the excursionists to the slaughter-houses, which are some little way off, and after a visit to the unloading stages, everybody went to the refreshment room in order to partake quickly of some refreshments. Some of the delegates let themselves be tempted, by the doors which were open everywhere, to enter the superb slaughter-house building in order to examine the interesting installations and see the work of the men from near.

Then the visitors, suitably refreshed, took the tramway which carried them back to Zurich, passing through the whole length of the town, and then took them on to the Zurichberg, at a height of 100 metres (328 feet) above the lake, where they saw the whole panorama of the city. The return journey brought them to the Polytechnic School; finally everybody wandered along on foot through the old city to the Lake the *Tonhalle*.

5th group : Oerlikon works.

A considerable number of the excursionists to Zurich went by a special train on the Federal Railway to Oerlikon, in order to visit the works there. After a short look at the works, which have been much enlarged during the last few years, part of them having been rebuilt entirely, a turbo-alternator set of 4,000 horse-power intended for the generating station in the town of Christiania was started running in the turbine test room. Then the visitors were specially invited to see a shunting locomotive, worked by accumulators, and an electric locomotive of the Lötschberg Railway. The latter was going to be delivered in a few days and set running shortly on the line of access to the Lötschberg (Spiez-Frutingen section); it weighs 88 tons (86·6 English tons). It will be feed with single phase current at 15,000 volts at 15 periods and has two single phase commutator motors of 1,000 horse-power each. Each of these is mounted on a bogie with three coupled axles. This new design has been very carefully worked out in all its details; it deeply interested the distinguished specialists who were pleased to recognize the activity and the success of the Oerlikon works in the domain of electric traction on standard-gauge railways.

After partaking of some refreshments in the waiting-room of Oerlikon station, which had been very prettily decorated for the occasion, the visitors took a special train on the Federal Railway and returned to Zurich.

* * *

The different groups of the excursionists to Zurich reassembled at 5 p. m. in the *Tonhalle* in order to partake of the dinner given in their honour.

This dinner was a great success, for food and drink were exquisite and the " Chambre XXIV " of the *Männerchor* of Zurich added to its beauties by song. Receive our thanks, ye devoted singers, you who with the gymnasts and the marksmen have called into being the valiant Switzerland!

When the time for the speeches arrived, Mr. Bleuler, State councillor, of handsome and serious appearance, rose and made the following speech in German :

" Ladies and gentlemen, the International Railway Congress has done Switzerland the

honour of holding its eighth session within our territory. The States and the administrations of the railways of five continents have sent as delegates to Berne, to the capital of our Federation, the authorities most skilled in the construction and operation of railways in order to examine and discuss, during many laborious meetings, questions of all kinds connected with the construction and operation of railways, and their improvement.

" Gentlemen, you have been kind enough to interrupt your labours, to adjourn your discussions, to leave your meeting-place, and what we feel especially deeply, to bring with you your ladies in order to give the canton and the city of Zurich the honour and the pleasure of your visit.

" Ladies and gentlemen, it is I who have the honour of addressing you a most cordial welcome in the name of the government of the canton of Zurich, and in the name of the municipality of the city of Zurich.

" Our authorities and our people, as well as the establishments which you have today honoured with your visit, feel very happy in welcoming you here and thank you sincerely for your attention. Our country is small as compared with those which you represent and it has but small resources at its command, in the great competition between nations, as compared with those you have available. However we hope that you will have been interested by the visits you have paid today to the workshops of the Federal Railway, to the car-building works at Schlieren, to the Zurich slaughter-houses and to the Oerlikon works; you will have taken away with you the conviction, that in spite of difficulties of an internal and an external order, and of the competition they have to meet, our industries have arrived at a high state of commercial and technical development, thanks to the knowledge of the managers of those establishments and thanks to the skill of the employed.

" Besides you all know, without doubt, that our industries have to fight seriously against their competitors. Our country lacks the most important raw materials, iron and coal. It is true that we are now-a-days trying to replace the latter as much as possible by our " white fuel ", by the power which we obtain from waterfalls. In spite of these difficulties our industries strive by all means in their power, by the quality of their produce, to prove equal to the competition encountered.

" You will have observed, in all our industries, the need and the strong determination, in spite of all difficulties, to keep their establishments and their produce at the height of technical perfection and of commercial suitability. May they always succeed in doing so, for the well-being of the country is wrapped up in the prosperity of our industries.

" Ladies and gentlemen, those of you who have visited the Swiss National Museum have been able to appreciate the value of this jewel of Zurich. In passing through its rooms, you will have been able to grasp the development of the customs and usages of our people from the most remote times until now. I venture to hope that you will take away with you an agreeable recollection of our National Museum. And no doubt Zurich will leave an equally good impression on those who have been able to contemplate it from the heights of the Dolder and of the Uetliberg, and to admire the surrounding country, the beautiful lake of Zurich with its background of snowy mountains.

" You have had the opportunity of visiting the slaughter-houses of the city of Zurich and their modern sanitary installations; you have been through our town with its well operated tramways, its well-kept streets and squares, its drainage, its public fountains, which supply abundance of excellent water, its quays which are of incomparable beauty, and its many other features. Ladies and gentlemen, you will certainly take away with you the impression that the municipal authorities of Zurich have neglected nothing to give the friends and the guests of the city a healthy and agreable stay.

" The water fête tonight, to which the setting sun invites us, will allow you before your departure once more to admire the beautiful situa-

tion of our town and to enjoy the charm of our lake with its shores covered with vine-yards and studded with villas; and I hope that this recollection will decide you to come again to us some day, to pay us another visit.

"I would express once more the great pleasure which the visit of you our guests has given to the authorities of the canton and of the city of Zurich, and I raise my glass to your health in expressing the hope that you will thake away with you pleasant recollections of your visit to Zurich." (*Prolonged applause.*)

Mr. Weissenbruch, general secretary of the Congress, replied in the following speech, not a word of which was lost in the great hall :

" Mr. Councillor, ladies and gentlemen, three gifts are necessary for the happiness of a people as for that of individuals : intellect, strength and beauty.

" Beauty, a beneficent fairy bestowed on Switzerland in the origin of time. The beauties of this wonderful country are innumerable; they are known to the whole world, as is illustrated by the alacrity with which the delegates have come from all countries in answer to the invitation of the Swiss government and of the Swiss Federal Railway.

" The happy inhabitants of this beautiful country also possess the gift of strength, thanks to its superior climate, so healthy, so invigorating, to which so many invalids come in order to regain their health. The bodily vigour of the Swiss has in all historical times been known to be the equal of their courage. They have covered themselves with glory on all the battlefields of Europe. It is through this courage that they succeeded in the mighty task of conquering and then of maintaining their independence in the midst of such powerful neighbours!

" Even at the present day we see the Swiss cantons rivalling each other in the gymnastic training of the young men of an age to serve in the army, and attaching the greatest importance to physical exercises.

" Finally, ladies and gentlemen, *mens sana in corpore sano!* Switzerland possesses the gift of intellect equally with the gift of strength. It proves that by the part it plays in the intellectual life of its neighbours. This fact is made all the more remarkable that it would seem its efforts would be counteracted by its political decentralization, by the diversity of its races, of its languages, of its religions!

" Enclosed today within the narrow limits of customs frontiers, Switzerland has understood the great importance of intellectual culture in the economic strife which has succeeded the heroic strife of nations. It has understood that it could only conquer by the attainments of its engineers, of its chiefs of industry, of its business men, by the skill of its workmen. The cantons accordingly spend very large sums on the popular education. The higher educational institutions of Switzerland can serve as patterns; it has many libraries and museums, its periodical publications are many in number.

" But, ladies and gentlemen, Switzerland possesses not only these three gifts, of intellect, of strength, and of beauty, which make for its happiness. It also possesses other gifts which add to our happiness : namely the gifts of the heart.

" I am sure of being your mouthpiece when I express our deep gratitude for the charming, the delicate, the attentive hospitality we have received here. We shall never forget the touching cordiality of our hosts and I think that I can assert in the name of all the foreigners present that we shall leave behind in this country durable, eternal friendships!

" Ladies and gentlemen, I propose to you to raise your glasses to the health of all those who have contributed to the charming entertainment which we have enjoyed today, and are still going to enjoy this evening :

" To the Swiss Federation! To the Federal Railway and to the private railways! To the canton and to the town of Zurich! To the local committee! To the Tramway Company and to the Steamship Company! "

This speech was uproariously applauded, and the delegates, whose excellent mood continued, went to the quay, where two fine ships, the *Helvetia* and the *Ville de Zurich* were waiting for them. Can we describe the delight of this trip on the lake? Can we describe the beauty of its shores? Can we describe the enthusiasm aroused by the illumination of the roadstead? No, let us leave it to everyone to tell in his own way of that never-to-be-forgotten night when all Zurich was on the water, gliding along in small boats and surrounding the delegates of the Congress with a sympathy of which a thousand bright fireworks showed the depth. For a long time to come the delegates will still hear the singers of "Chambre XXIV" ardently glorify their country in the profoundly-moving song of *Oh mein Heimatland*. Zurich, to you our gratitude!

Banquet on 14 July 1910, offered by the Federal Council.

About twelve hundred people accepted the invitation of the Federal Council to the official entertainment organized in honour of the Railway Congress Association, in the fine Federal Drill Hall. Several members of the Federal Council, the diplomatic corps, the chiefs of the international offices which are located in Berne, and other distinguished guests attended this assembly, which was adorned by the presence of a large number of ladies. The Hall presented a magnificent spectacle. During the dinner, the excellent town orchestra executed a choice programme.

Towards the end of the dinner, Mr. Comtesse, President of the Swiss Confederation, made the following speech:

"Ladies and gentlemen, allow me in the first place to discharge a duty in which you will join. Just as you sent a message of sympathy to the United States on the occasion of the celebration of its independence day, let me today address, from this place, a message of sympathy and of friendship, and our best wishes for prosperity, to the French Republic, which today celebrates its *fête nationale*.

"Gentlemen, to you who are delegates at the eighth session of the Railway Congress Association, I bring you in this banquet, which marks the approaching end of your labours, the cordial compliments of the Federal Council and I express the hope, which will not be frustrated, that this session, which marks the twenty-fifth anniversary of your activity, will prove the starting point for further progress in the organization and operation of railways.

"It is always a refreshing spectacle to see scientists and technicians coming from all parts of the world, as you have come here in great numbers, to communicate to each other the results of their work and their experiments and to investigate together how further progress can be added to the progress which has already been made, and further conquests to the inheritance of humanity.

"Among all the congresses which meet from time to time in different parts of the world, there are none exceeding in importance that of the congresses of your association, none whose work is more useful, for its object is the continual improvement of the greatest public service in the world.

"They have, moreover, this result: by the meeting of a large number of scientists, of engineers, of inventors, of technicians, there is demonstrated, more than in any other way, the beneficial sovereignty of science and of men of science, that continually-growing unity of the world of science, that natural result of the unity of science itself, a distant, but certain, omen of a future of which you, gentlemen, are the forerunners, when the nations will be but a vast association of workers collaborating in the same work, the advancement of science to benefit

View of the federal drill hall arranged for the banquet given to the members of the Congress by the Federal Council, 14 July 1910.

humanity, knowing no other strife but the peaceful strife of work and making no conquests, except over nature and over ignorance.

" They have even this, if possible still higher result, that if they have the object of improving the equipment of iron roads, the quickness and the security of carriage, then they bring more closely together, and establish permanent communication between the men whose mission in the world is the work on railways, that is the work which must most promote the unity of nations.

" Such was also the function which His Majesty the German Emperor attributed to your Congress when he addressed to your session at Washington, five years ago, a telegram in which he said that your Congress Association, in benefiting international traffic, seemed to him the most effective way of fostering mutual understanding and bringing together the nations in peace.

" Must the bringing together which results from a reduction of time and distance not naturally ensure a bringing together in the domains of thought, of sentiment, in mind and in heart? Do not all the ressources which science today places at our disposition assist in this result of bringing governments and nations closer together? Do not the locomotives which run across our frontiers, work at this every day, by continually increasing our facilities for the exchange of produce and by facilitating the movements of men?

" If we all, sons of different nations, have the ambition to serve our respective countries and make them prosper, should we not also have the ambition, not less high, of cooperating in works which have as object not only the material prosperity of humanity, but the policy of mutual understanding, of harmony and of peace, which is the ideal of all of us, and which can not be realized except by the union of men of good will and of conscience, and by the efforts of all.

" Gentlemen, Switzerland will always be proud of having been able to make its small contribution to that work which has as its object the progress you strive for; and it will always be happy every time it is selected as the meeting place of congresses which work, like yours, at works of progress.

" It has, it is true, only modest resources which it strives to supplement by extra goodwill and by the cordiality of its reception, and it would always hope to think it did not fail too much in its object, and that the guests which it receives will retain an agreeable recollection of their visit.

" We would have wished to offer you, during the session of the Congress, sunny days, vistas without clouds, instead of the wet days and too abundant showers which the skies have bestowed upon you. But when I spoke of this to one of the most eminent members of your Association, and when I grieved over this disappointment, he consoled me by saying : " Do not " distress yourself; the Railway Congress is a " working Congress, and the rain only helps " to stimulate our eagerness for work."

" I replied : " The 1910 Congress at Berne " may then be described as follows : There " has been much rain, but there has been much " work."

" I raise my glass in honour of the eighth session of the International Railway Congress Association; I drink to the health of its members! " (*Much applause.*)

Mr. A. Dubois, President of the Permanent Commission of the International Railway Congress Association, answered in the following terms :

" Mr. President, ladies and gentlemen! The International Railway Congress Association is as proud of the great honour done to it by the Federal Government, as it is touched by the friendly and cordial way in which it has been received in your beautiful country. This reception, I may be allowed to tell you, we expected, we promised it to ourselves; for we know how many other associations have been, like us, able to enjoy a hospitality which is always great and generous, always impressed with courtesy and goodwill

" Many of us have come to Switzerland, from all parts of Europe and from beyond the seas. Was not this necessarily so? In addition to the attractions, springing up at every step, which are offered to the traveller by this country so blessed by nature, are there not powerful attractions to the engineer, to the builder and operator of iron roads, to the railway man? Does one not find remarkable and grand solutions, of the most difficult problems which may confront the engineer charged with planning and building railways? Does one not find model constructional works, carried out under the most varied and most difficult conditions? Does one not find a large number of ingenious and rational applications of special systems of traction which science has presented to practice and thanks to which it is possible one can build and operate with advantage, lines of communication which for a long time were considered impracticable?

" Your technical schools, with a perfect organization, have acquired a great reputation in other countries; they produce trained engineers, well prepared for their career, profoundly imbued with the love of work and devoted to their profession.

" The astonishing progress in the domains of electrotechnics has thrown open a vast field for action in which your engineers and your constructors shine.

" The complex and often delicate questions which arise in railway working. have led with you to investigations, to discussions which have aroused a vivid interest in the economic world.

" It was two Swiss jurists who, in 1874, were the initiators of the international legislation concerning the carriage of goods, in force for the last twenty years. And if, as can now be foreseen, and as the wish was expressed at one of the first sessions of the Congress, this legislation is supplemented in the near future by a law controlling the carriage of passengers, one will recollect the learned and deep investigations into the question, published by another Swiss jurist in 1897.

" In whatever direction one explores the vast domain of railways, one always finds indications of the investigations, of the works and of the successes of your countrymen.

" The Congress was certainly in a suitable place with you; we are grateful to the Federal government for giving it us and for having made it so beautiful.

" The work of the eighth session has gone on steadily, and is nearly completed. Soon we shall have to begin our homeward journeys; we shall do so with regret and shall carry away with us a lively feeling of gratitude. Here I am, having arrived nearly at the end of a presidency which has lasted seventeen years. I am happy that today I still am able to act as the representative of a stately assembly in order to express to you the warm and deep sympathies which are aroused in the hearts of all those who have been able to come to your homes, and to live your life, and have themselves been able to appreciate the qualities inherent in your race : an upright nature, a determined spirit, an innate good sense, a patient energy, a love of a simple family life, an incessant search after progress, an ardent patriotism, the inspirer of manly virtues; a whole mass of good qualities which have earned for your country the esteem, the admiration and the respect of the most powerful nations.

" Ladies and gentlemen, I call upon you to raise your glasses : to the greatness, to the unlimited prosperity of the free and proud Swiss nation! " (*Great applause.*)

After this speech, the band played in succession the national anthems of the chief countries represented at the banquet.

Mr. Winkler, vice-president of the Swiss section of the Permanent Commission of the Congress read the following telegram addressed by the President of the United States to Mr. Franklin Lane, senior delegate of te American Government :

" I send greetings to the whole international railway Congress and sincerely hope that their

conferences will result in general benefit and improvement of railway methods."

WILLIAM H. TAFT.

This message was received with prolonged applause.

The banquet was followed by an entertainment given in honour of the Congress by the chief musical and gymnastic societies of Berne.

The programme was carried out in the most successful way; the last part, "*Life in the Swiss mountains*," in particular, was very much applauded.

The entertainment lasted till nearly 1 a. m., and will remain ineffaceable in the memories of all those who were present.

Excursion to the Engadine, on the 18, 19 and 20 July 1910.

It was an animated scene, bearing however the imprint of a certain amount of sadness at leaving the very hospitable city of Berne, of which the Congress had been the spoilt guest during a fortnight, when the remaining members of the Congress, on Monday 18 July, at 9 a. m., boarded the special train which was to take them into eastern Switzerland, among the snowy peaks of the Engadine, to St Moritz, sometimes named the "Mecca of the seekers after health and pleasure".

After an excellent lunch given by the International Sleeping Car Company, the one hundred and fifty members of the Congress arrived at 2 p. m. at Chur, where a special train, provided by the Rhetian Railway Company, awaited them in order to take them through the Grisons by the Albula line, one of the finest creations of the genius of man.

We must not forget to mention that on the way a collection was made for the benefit of those who suffered by the disastrous floods of the Upper Rhine, at Landquart, the sad signs of which appealed to all the travellers.

The Rhetian Railway is a highly-interesting narrow-gauge system from the point of view of a permanent-way engineer. The Albula line, connecting Thusis and St. Moritz, has a gauge of 1 metre (3 ft. $3\,^3/_8$ in.); it goes up the valley, sometimes on the one side, sometimes on the other, gaining height by means of helicoid tunnels of hardly conceivable boldness.

The steepest gradient between Thusis and Filisur is 25 per mil, and attains 35 per mil between Filisur and Bevers; the line rises from a height of 700·50 metres (2,298 feet) at Thusis to one of 1,818 metres (5,965 feet) at Spinas, the culminating point; it then descends to 1,773 metres (5,817 feet) at St. Moritz.

The sharpest curves have a radius of 120 metres (6 chains).

There are many smaller tunnels, having a total length of 10,142 metres (6 miles 532 yards); in addition there is the great Albula tunnel, which has a length of 5,865 metres (3 miles 1,134 yards). The view, from its exit, of the Beverin valley, is very impressive.

The arrival at St. Moritz took place about 5 p m., after three hours of splendid and striking scenery, during which one did not know which to admire most, the picturesque and severe character of the country or the genius of the engineers who were able to reconcile the art of builder with the care of keeping intact the natural beauty of the sites.

Thanks to the excellent organization of the excursion, each member found ready for him at St. Moritz the accommodation which had been reserved for him at the best hotels in the place.

On Tuesday 19 July, a special train awaited the members at 8 a. m., in order to take them across the Bernina pass and bring them close to the Italian frontier.

The Bernina Railway, which connects St Moritz and Tirano, has a total length of 60 kilometres (37·3 miles) and had only been fully opened to traffic a few days before. Electric traction is used; continuous current at 750 volts is supplied by the four electric substations at Campo Cologno, Poschiavo, Bernina Hospiz and Pontresina. At each of these there is a converter set and an accumulator battery; the Brusio power station supplies alternating current at 25,000 volts, 50 periods, to the converters at these substations.

The track has a gauge of 1 metre (3 ft. 3 3/8 in.) and steepest gradients of 70 per mil; the sharpest curves have a radius of 45 metres (2 1/4 chains). The line winds along the slopes of the mountains, through curved tunnels which make it possible to gain considerable height without in any way injuring the beauty of the scenery. There are thirteen tunnels; the two longest are 700 and 300 metres (765 and 328 yards) in length.

The exceptionally favourable weather made this excursion very attractive. The view of the Morteratsch glacier, which soon appeared in its immaculate whiteness, aroused great enthusiasm among the members.

An excellent cold lunch restored the energies of the members at Le Prese, the extreme point of the excursion, and a charming walk along the shores of the lake of Poschiavo quickly passed the time until the return train started.

In the evening, at 8.30 p. m., the members met at the *Grand Hôtel*, where a magnificent banquet was given to them by the municipality and the Society for developing St. Moritz. The excellent food and the seductive wines soon promoted the utmost cordiality among the guests.

During dessert, numerous speeches were made : by Mr. Hoffmann, president of the Society for developing St. Moritz, to welcome the members of the Congress, and by several delegates, in the name of the Congress and of all the countries represented, to thank the local authorities and the people of Switzerland, for the splendid way in which they had been welcomed.

On Wednesday 20 July, an excursion in brakes was arranged to the Maloja in the morning; and in the afternoon one by cable railway up the Muottas Murail. These most successful excursions thus ended the series of voyages organized for the Railway Congress, and they will leave ineffaceable memories in the minds of all those who took part in them.

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